ARMY ORDNANCE

VOL. XXVI, No. 144 MAY-JUNE, 1944

Armament Production
Maj. Gen. Thomas J. Hayes

Teamwork for Victory
K. T. Keller

Our Fighting Equipment
Maj. Gen. G. M. Barnes

Ordnance in Jungle Warfare
Maj. Gen. Albert W. Waldron

American Ingenuity
Dr. Charles F. Kettering

The Baruch-Hancock Report
A Summary

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

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ARMY ORDNANCE

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For Victory through Armament Research, Production, and Supply

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THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of over 22,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-five years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peacetime armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 544.) There are twenty-three local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the Nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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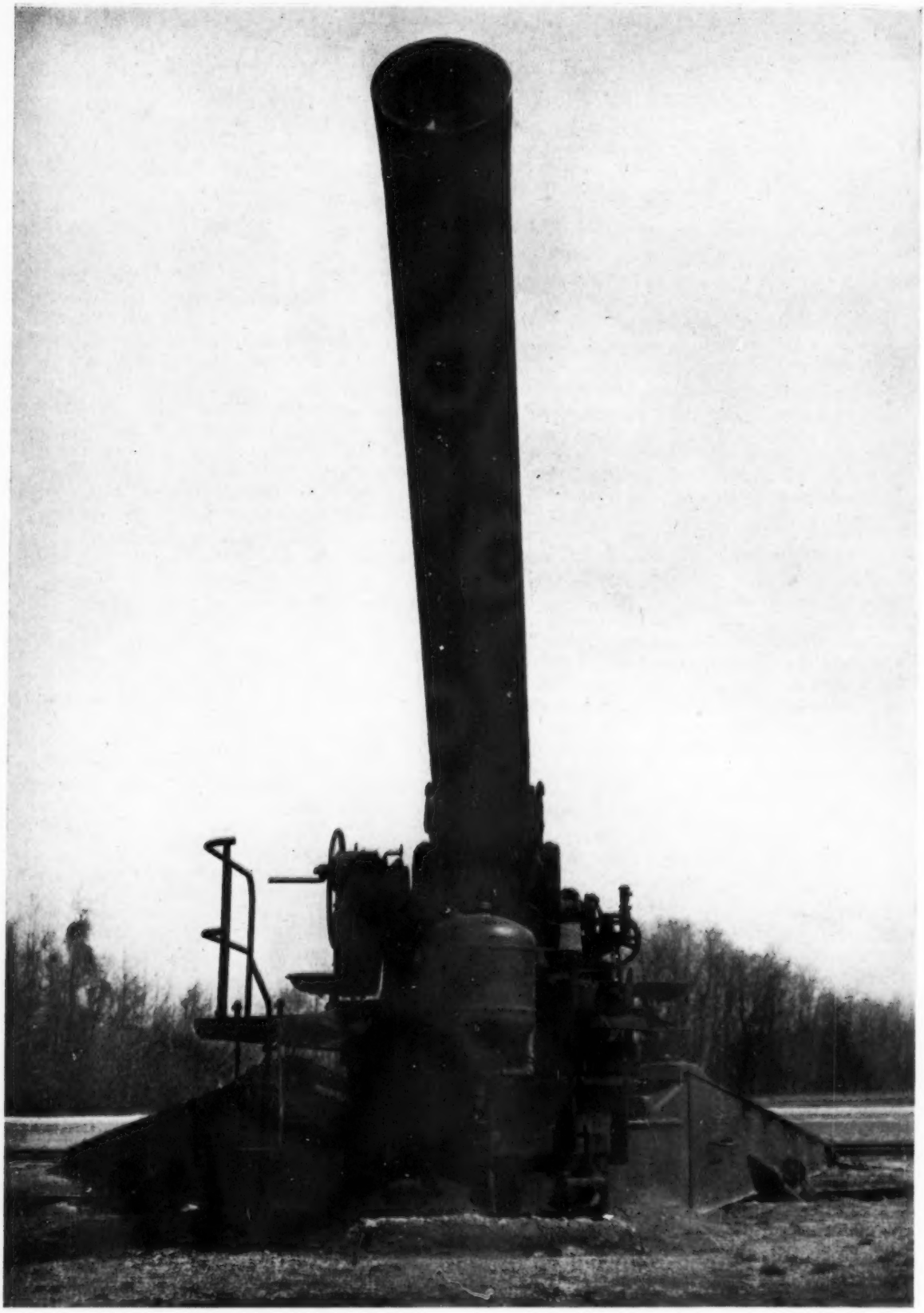


"The 240-mm. howitzer is one of the most accurate and most destructive mobile weapons of siege warfare ever devised. It is the embodiment of our Ordnance principle of maximum firepower. If a rapier thrust be demanded in battle, Ordnance has the weapons to meet the condition. If a battle-ax be required to hack and hew at the enemy position, again Ordnance has the weapon available. Our 240-mm. piece is a modern battle-ax against which few military targets can stand."

—Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance.

ARMY ORDNANCE

Volume XXVI MAY-JUNE, 1944 No. 144

Armament Production

The Problem of Ordnance Manufacture in Fluid Warfare

Maj. Gen. Thomas J. Hayes

THE Army of the United States is organized into three basic groups—Army Ground Forces, Army Air Forces, and Army Service Forces. The Ordnance Department, with Maj. Gen. L. H. Campbell, Jr., as its Chief, is one of the technical services of the Army Service Forces.

In the performance of its mission, the Ordnance Department is organized into four operating divisions as follows: the Technical Division, which is charged with the research and the experimental and developmental work preceding the birth of a new item of ordnance; the Industrial Division, which is responsible for the procurement, production, inspection, and acceptance of all ordnance matériel and with the performance of many collateral and related responsibilities; the Field Service Division, which is charged with storage, distribution, and maintenance; and the Training Division, which is responsible for training officers, enlisted men, and troop units for the performance of Ordnance field duties.

In this discussion, we are concerned with the Industrial Division of the Ordnance Department. It is our job to produce Ordnance in the quantities and at the times necessary to meet the needs of our Army, Navy, and Marines, and of our allies. We are responsible for the production of all Army ordnance for use on land, on sea, and in the air. We produce weapons from the Tommy gun or other hand arms on up through all calibers and types to the huge 16-inch seacoast gun. We produce ammunition from the small-arms cartridge to the largest blockbuster bombs, and all the combat and transport vehicles from the jeep to trucks and trailers, self-propelled artillery, armored cars and tanks.

The better the job done by the Technical Division in keeping the United States ahead of our enemies in Ordnance design and development, the tougher it becomes for the Industrial Division. What is designed today, the Army may demand tomorrow—and in huge quantities. A new weapon, a new tank, or any new item may make obsolete one for which we have established quantity production. We then have to cancel orders for the one, with all the grief this entails, and proceed to provide the facilities, tool up, and get into production on the other. Changes are inevitable—changes in organization, tactics, design and specifications, and production. In this connection, Dr. C. F. Kettering has said that "mastery of the art of change has been one of America's greatest contributions toward victory."

How do we know what to produce, how much, and when? The Army Supply Program is our procurement bible. It represents the translation of the military needs of our Army, Navy, and allies—based upon military and strategic plans—into military requirements expressed in terms of items of issue, quantities thereof, and time of availability. Our production programs must be such that these requirements will be met.

The Army Supply Program is not static. It undergoes a major revision quarterly in the light of changes in the military situation and in military plans, and there are many interim changes from day to day as military requirements change. Our Ordnance production program must be adjusted to conform to each change to the end that we will have enough and on time—but not too much nor too soon. This latter requirement is necessary if we are to obtain the most effective utilization of our resources—facilities, materials, man power—which are not limitless.

LET us now consider our organization and setup for the management of our procurement programs. Our determined policy calls for maximum practicable decentralization. Our job in Washington is one of general direction and control; our Washington office is relatively small, our field organization is large. In Washington we have the general offices of the Industrial Division, and three matériel branches responsible for our procurement programs in their assigned classes of matériel as follows: (1) the Small Arms Branch, headed by Brig. Gen. James Kirk, responsible for small-arms weapons and small-arms ammunition; (2) the Artillery Branch, headed by Brig. Gen. Gordon M. Wells, responsible for all weapons from the 20-mm. on up, together with all the fire-control and contributory equipment essential to their combat use; and (3) the Ammunition Branch, headed by Brig. Gen. Rosswell E. Hardy, responsible for all artillery ammunition, bombs and other aircraft ammunition, and all other ammunition including mines, grenades, pyrotechnics, etc., exclusive of small-arms ammunition.

Each of these branches has regional or suboffices outside Washington. For example, under the Ammunition Branch there is located in St. Louis the Office of the Field Director of Ammunition Plants, charged with the administration and control of more than fifty Government-owned contractor-operated ammunition, explosives, and chemical plants and works. Similarly, small-arms ammunition is handled at Frankford Arsenal by a suboffice of the Small Arms Branch. The Artillery Branch has suboffices at four arsenals.

A fourth matériel branch, concerned with automotive ordnance, is located in Detroit. There, the Engineering and Manufacturing Branch of the Office, Chief of Ordnance, performs the same functions with respect to combat and transport vehicles as do the Washington branches in the other classes of matériel.

General Hayes is chief of the Industrial Division of the Ordnance Department, U. S. Army. This is an address delivered at the Ordnance Production Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

So much for our top organization. How do we get our orders placed? Who produces the ordnance to meet requirements?

In the first place, we have our six permanent manufacturing arsenals—Watertown, Springfield, Watervliet, Picatinny, Frankford, and Rock Island. Their contributions to the war effort have been of inestimable value. They have more than justified our investment in them. They have been and are great national assets. We are proud of them and I wish that I had more time to tell you of their oustanding performance in this war. But in the dark days of 1940 following the Dunkerque evacuation, it was apparent that the capacity of these arsenals and of commercial arms and explosives plants was insignificant compared with the requirements which became increasingly evident. We needed weapons and ammunition, and we needed them badly.

To meet the ammunition requirements there were constructed and placed in operation a large number of plants and works owned by the Government and operated for the Ordnance Department by private industry. These are our so-called GOCO (Government-owned contractor-operated) plants. They include smokeless-powder plants, TNT and other high-explosives plants, ammonia and other chemical plants, bomb- and shell-loading plants, and small-arms-ammunition plants. This construction program was carried out with the boldness and imagination that the emergency situation demanded. Adequate capacity was provided, and adequate supply to meet all requirements was insured. These plants have been operated with marked efficiency and success. The safety record is almost unbelievable.

Likewise, in the case of weapons, combat vehicles, fire-control equipment, and all other items of Ordnance, midsummer of 1940 witnessed the initiation of a period of intense activity to provide production capacity to meet ever-mounting requirements. Although a great deal of new construction was necessary, in the main the job was done by converting plants from their normal peacetime production to munitions production. Here American industry proved its adaptability; the assembly line proved that it understands war. A magnificent job has been done—one made possible only through the closest coöperation and teamwork between industry and Ordnance.

THE foundation for this was laid in 1922 when the Ordnance district system was established and Ordnance district offices set up through which close contact was maintained with the industrial plants and areas throughout the country. When the emergency came, these district offices were vastly expanded and their rôle changed from one of planning to one of execution.

Our contracts with industry are negotiated, placed, and administered by these thirteen Ordnance districts. The allocations are made to the districts, based upon their available or potential capacity, by the matériel branches of the Industrial Division. In the placement of orders, the districts have insisted upon subcontracting as much as possible in order to utilize available capacity or facilities, and they have seen to it that the smaller war plants have been utilized to the fullest extent practicable under existing conditions. We feel that Ordnance has done a very great deal for small business. We will continue to use the small plants provided that we don't have to sacrifice quality standards—which we will not do—nor delivery requirements—which we cannot do.

I cannot say too much in commendation of our Ordnance districts. Their primary and overriding responsibility still remains that of obtaining the required production and delivery of ordnance. To this has been added many important collateral responsibilities, including renegotiation, price adjustment, contract terminations, etc., and they will play a most important part when the "reconversion" period arrives.

Until recent months there wasn't enough of anything. Consequently, it was necessary for us to push ahead on all fronts more or less simultaneously and with our effort spread over the wide range of Ordnance products—guns, ammunition, vehicles, and the thousands of related products that go to make up a completely equipped army as far as ordnance is concerned.

The record, however, is one of which all of us have a right to be proud. We are proud of our arsenals, the district offices, the Army Ordnance Association—which has played such a big part both in the peace years and during the war—and the industrial concerns which really did the job for us.

OUR rate of production—our "sales volume" as we like to think of it—has been running for some months at better than a billion dollars a month, or twelve billion dollars a year—a staggering figure representing three times the volume of the entire automobile industry in the best peacetime year. It is now at about the maximum that will be required of us.

It is interesting to note that as the volume of our production increased—as the "know-how" was established in our industrial manufacturing plants—our costs decreased, in some cases materially. I believe that the downward trends shown by small arms and artillery are representative of what should be expected in increasing volume production on relatively stable items of equipment, and that the fluctuating curve for tank-automotive equipment, which is above the average of the Department, has remained up there primarily because of many changes that were necessary to equip these vehicles to the satisfaction of our services and because of the rapid changes we've had in models.

Two years ago we used to hope for the day when our production would reach the peak—for then, we thought, we could just let it roll out month after month. But of course it doesn't work that way, as we all know. Many programs have been and will be cut back. Our maximum rate reached last month does not represent the maximum rate for all products: some of these were attained months back; tanks and artillery, for example, and other items have not reached or even approached the peak rates required in 1944 or 1945. We are seeing what General Campbell has called the "fluidity of war"—the ever-shifting emphasis from what were the "hot" items to those with a lessened demand and vice versa. It's the "vice versa" that characterizes our 1944 program; that is, very urgent demands must be met for new products on a highly selective basis.

One thing stands out clearly. The job from here on is not and will not be easy just because we have reached and even passed the maximum over-all production rate. No belief would be more dangerous or potentially more crippling to our effort. The fact is that we are being called upon now, and the pressure is going to increase in the months ahead, to accelerate our production on many new items. Our ability to supply these new and improved items will be devastating to the enemy and decisive as to the length of the war. If we fail on account of a complacent attitude or for any other reason it will be as costly as if we had failed in 1942 or 1943.

O.W.I.

Teamwork for Victory

The Successful Operation of the Ordnance-Industry Partnership

K. T. Keller

MY personal experiences and observations over the last four years of the relationship which has developed between Ordnance and industry in their joint efforts to arm this country's fighting forces convinces me it is one of the genuinely wholesome accomplishments of our time. In its practical results, it has continued to equip our soldiers with the most effective weapons that any army has ever had.

The Ordnance-Industry team has more than matched enemy developments in weapons of offense and defense, and it is producing weapons that surpass the enemy's in every category. For a long time after war appeared inevitable, the Ordnance Department was restricted to miserably small expenditures for research and development that should have been done earlier and on a much more extensive scale. Starting late in this international ordnance race it is all the more gratifying that such extraordinary things have been achieved.

The success of this Ordnance-Industry team is due principally to two factors: First, Ordnance approached industry as a recognized partner in the development of military weapons and found industry willing to pool its ingenuity and experiences; secondly, Ordnance inspired mutual confidence and respect in its dealings and encouraged industry to assume its rightful responsibility for the success of the war program.

Mr. Keller is president of Chrysler Corporation. This is an address delivered at the Ordnance Production Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

So in any attempt to assay the relationship between Ordnance and industry we have to go back a few years to get a proper perspective as to its worth and significance both to the war itself and to the postwar period.

When the defense program began to develop, and much more so when it grew into a war program, there were three vital questions to be answered: What weapons would be needed? How many would be needed? When would they be needed? Ordnance realized that if it could go to American industry with even approximate answers to these questions, it could count on industry to produce them. It believed, also, that it could enlist industry to work coöperatively with its own talented officers and get industry's enthusiastic interest.

The faith which Ordnance reposed in industry has not been misplaced. I believe that the relationship it has created will be a big factor not only in winning the war but in keeping the world at peace thereafter. There is every reason why this approach should have been so successful. There is every reason why this team should continue to work together whether we are at war or peace, for the pattern has been established, the results are being obtained, and the need, in some degree at least, will continue.

The Nation has an asset it did not possess a few years ago —one upon which it should continue to realize in the years ahead. The basis, as I see it, is much more than that of a customer relationship. It is true that in one sense Ordnance is industry's customer for the war items which it purchases.

But Ordnance is not a customer in the ordinary sense because war is not ordinary; its requirements cannot wait upon the ordinary processes of commercial trade.

Ordnance was in the position of a buyer who simply had to buy quickly, in large quantities, and for needs that could not be accurately forecast. Moreover, they were subject to emergency changes due to the fluid character of the war.

In order to obtain the products it had to buy, industry, on the other hand, had to be adapted to their production and equipped, expanded, and financed to produce them. Industry for the most part was inexperienced in making them, Ordnance was inexperienced in buying them on the scale demanded, and time did not allow for the kind of negotiations ordinarily employed in commercial practice.

SUCH considerations as these have to be taken into account by both industry and Ordnance, and they impose certain obligations on the part of both. They underlie the need for both to recognize that adjustments are necessary, inevitable, and to be approached in a coöperative, understanding spirit. We can better realize the importance of these elements in the relationship if we keep in mind one fundamental fact that is so commonplace as to be almost overlooked—this war is just as vital to industry as it is to the Army.

The Army cannot function for us as effectively as we expect it to do unless it has the tools of war, and the only source of these tools is American industry. These considerations should also determine the approach of both industry and Ordnance to the contracts they make with each other. On the part of industry, the approach to the contracts with the Government should be from the standpoint not of selling something to the Government but of supplying our armed forces with the weapons they need to do their work. On the part of Ordnance, the approach should be from the standpoint of dealing with its war partner on the basis of making as reasonable terms as mutual confidence should determine.

It is necessary to have contracts for the orderly carrying out of industry's obligations to the Government and to its employees and suppliers. Money is needed to buy materials, to meet pay rolls, and to keep things running, and contracts implement these practical considerations. Where a spirit of fairness prevails on both sides, it is relatively easy to come to a mutual understanding on a contract; where a lack of confidence prevails—where unreasonableness due to lack of knowledge makes a contract difficult to arrange—then experience has to be the basis on which adjustments may be predicated.

This should be the essence of sound renegotiation, because renegotiation without fairness on both sides leads not only to injustice but to chaos in the production processes themselves. Industry should not wait for the representatives of the armed forces to insist that they do a good job; industry should do a good job for its country.

With such an understanding, industry should be just as impatient with careless, dilatory handling on the part of the Army as the Army should be if industry fails to recognize the importance of getting out the tools of war on time. By the same token, the armed forces have obligations in their partnership with industry which are equally important. The Army, for example, should not place one industry in a disadvantageous position with respect to another industry. Teamwork between industry and the men in uniform, with competent policing for fairness on both sides, can do wonders and has already done them.

It behooves industry to back up the armed forces because they are our representatives in fighting the war, and it behooves the services to back up a sound, fair, and competent industry because it is industry that supplies them with the tools of war.

Based on my experience, I believe both partners in the Ordnance-Industry team wish to observe these principles. I believe also that they have been fairly successful in observing them and acting upon them. The job confronting us, however, is far from being done. We still have a war to win, and there is still an urgent need for close coöperation between industry and the services.

The relationship that has brought us this far needs to be cultivated and strengthened. The job of supplying the armed forces with the best weapons we can jointly devise and produce affords no time to relax our vigilance or our efforts. I am also hopeful that what we have been doing together and the spirit in which we have been doing it will have produced such results that when the war ends this relationship will be useful to the country in two additional respects: first, it should enable the problems of termination to be solved in the same understanding way between the same people who have dealt with each other to date; secondly, it should enable industry and Ordnance to work out together a practical plan for continuing coöperation for the future peace of the United States.

THE weapons of war will change as the latest developments of science, engineering, and manufacturing processes advance in this country. No country is adequately armed for defense unless its armament is of the latest and most effective design and is kept ahead of all competition.

It will not suffice to perpetuate the buildings, equipment, and the relations of Ordnance and industry on the basis of making tanks, cannon, ammunition, and the other items for fighting wars. This well-grounded relationship should be directed to the most intelligent and scientific study of the art of designing and making superior weapons—weapons to fit the new tactics which are sure to be devised or desired to insure a lasting peace.

We have seen the marvelous weapons that have come forth during even the last few months and others still more remarkable are now in development. What has been done under the stress of fighting a strong enemy certainly can be done even more effectively when we are not retarded and diverted by the emergencies that require so much of our attention. To me this is the real challenge and should be the first objective of the Ordnance-Industry team.

Will the Army Ordnance Association dedicate itself to research and development?

Will the members from both Ordnance and industry carry on this research and development without the stimulation of an active enemy?

Can we, working together, lead our American people to support and finance a continuing program of development?

In the answer to these questions lies the usefulness and the greatness of the Army Ordnance Association.

EDITOR'S NOTE.—In a talk before the Economic Club of Chicago last January, Mr. Keller said: "I should like to see the United States always so modernly prepared in its own individual plants that nobody at any future time will dare to upset the peace of the world without reckoning deliberately on America's influence to determine the outcome."

Industry Integrating Committees

The Ordnance Program for Disseminating Production Techniques

Roy T. Hurley

DURING peacetime, Ordnance arsenals maintain a skeleton "know-what" limited by the funds available. It is this "know-what" that makes it possible to produce ordnance material in the quantity and quality required when war comes. As the danger signals of war begin to fly, the arsenal turns to industry, and, by placing relatively small contracts, "know-what" is developed into "know-how."

As war comes, the vertical organizations of the Office of the Chief of Ordnance and the Ordnance districts go to work. Contracts are placed, and engineering, inspection, fiscal, legal, machine-tool, and other necessary branches are developed in the district.

At the same time, the "know-what" of the arsenal and the "know-how" of the experienced manufacturer go to work through the horizontal organization of the Ordnance Department via the Ordnance industry integrating committees. An industry integrating committee is composed of a chairman (the chief of the branch concerned), a deputy chief (the officer in the Ordnance Office in charge of the procurement of the item), and an assistant chairman (a man from industry selected from the organization having the "know-how"). The arsenal and each manufacturer of the item has one member on the committee.

Through the committee, the arsenal's "know-what," drawings, testing methods, etc., are made available to each member. Also, the experienced manufacturer's tool design and experience, material cutting speeds and feeds, gages, inspection, controls, and all the elements of manufacturing "know-how" are made available to the new contractors without cost. Inventories of raw material, semifinished and finished parts, subassemblies, etc., are made available so that the new contractors can train labor and test and adjust tools and machines. Operators of tools and machines and assemblers are sent to the plant of the experienced manufacturer for production training. This permits the new contractor to start production with a very real amount of "know-how."

This form of integration has made it possible to get production of tank engine starters, for example, under way in 10 weeks instead of the normal 10 months; has made it possible to start production of mechanical time fuzes in 90 days instead of the usual 12 months; has made it possible to obtain millions of sets of tank-track components from over 200 small manufacturers in complete harmony with a smooth integrated flow of production. This form of procedure has been used successfully for all the items throughout the entire range of ordnance components up to and including large and complicated fire-control directors.

This very typical Ordnance procedure is by nature simple and direct, as all effective procedure must be. It can best be visualized if it is compared to a well-woven piece of strong cloth. The weaving of the vertical units of the Ordnance Office and the Ordnance districts with the horizontal units of the arsenals and industry integrating committees results in a production fabric that is strong and useful—a fabric that effects early and maximum production of the highest quality at the lowest cost. It is a simple way of getting the most for the least. Examination of Ordnance records will disclose the fact that the cost of Ordnance items began to drop rapidly with the formation of the first industry integrating committee by Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance. Credit also must be given to the branches, the districts, the arsenals, and industry for the way in which free interchange of men, material, and knowledge was put to work for the benefit of the Nation.

THE Ordnance-Industry integration committees on small arms, under the chairmanship of Brig. Gen. J. Kirk, chief of the Small Arms Branch, Ordnance Industrial Division, are: Ammunition Box, Carbine, Machine Gun, Metallic Belt Link, Pistol, Small Arms Ammunition.

The committees on artillery, under the chairmanship of Brig. Gen. G. M. Wells, chief of the Artillery Branch, Ordnance Industrial Division, are: Armored Vehicle Fire Control, Director, Field Howitzers, 37-mm. Gun, 90-mm. Antiaircraft Gun, Heavy Mobile Carriage, Tank Gun, Intermediate Antiaircraft Carriage, Light Mobile Carriage, Optical Instrument, Major Caliber Antiaircraft Carriage, Mobile Carriage Recoil Mechanism, Remote Control Systems, Trench Mortar.

The committees on tanks, under the chairmanship of Brig. Gen. Walter P. Boatwright, chief of the Office, Chief of Ordnance, Detroit, Mich., are: Armor Plate, Band Tracks, Engines, Gun Mounts, Half-Tracks, Heavy Trailers, Heavy Trucks, Light and Medium Trucks, Light Trailers, Medium Tanks, Track Prime Movers, Vehicle Axle and Transmission, Winches, Wood Cargo Bodies.

The committees on ammunition, under the chairmanship of Brig. Gen. R. E. Hardy, chief of the Ammunition Branch, Ordnance Industrial Division, are: Adapter Booster, Adapter Cluster, two on Antitank Mines, 100-pound Chemical Bomb, Fragmentation Bomb, 100-pound Practice Bomb, Boosters, Burster, 90-mm. Drill Cartridge, Flare Parachute, four on Bomb Nose Fuzes, two on Base Detonating Fuzes, Dummy Fuze, Mechanical Time Flare Fuze, Mechanical Time Antiaircraft Fuze, four on Point Detonating Fuzes, Antitank Mine Fuze, Hand Grenade Fuze, Grenade Adapter, Rifle Grenade, Fuze Seat Liner, two on Mines, Parachute for Fragmentation Bomb, Percussion Primer, 20-mm. Projectile Ball, Antitank Rocket, Antiaircraft Target Rocket, 20-mm. High Explosive Shell, 37-mm. Practice Shell, 60-mm. and 81-mm. Mortar Shell, 37-mm. and 40-mm. High Explosive Shell, 75-mm., 90-mm., and 3-inch High Explosive Shell, 105-mm. and 4.7-inch High Explosive Shell, 155-mm. High Explosive and Chemical Shells, 60-mm. Illuminating Mortar Shell, 75-mm., 90-mm., and 3-inch Armor Piercing and Armor Piercing Capped Shot, 37-mm. Armor Piercing and Armor Piercing Capped and 40-mm. Armor Piercing Shot, 57-mm. 6-pounder Armor Piercing Shot, 20-mm. Armor Piercing Shot, Ground Signal, Small G. P. Bombs, 40-mm. Tracer and Igniter Shell.

Mr. Hurley is special assistant to the president, Bendix Aviation Corporation. This is an address delivered at the Ordnance Production Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Termination of Contracts

Problems Involved in Cutting Back War Production

Col. I. A. Duffy

THE problem of termination divides itself today into two separate and distinct phases. The first phase deals with the development of fundamental policies. Those policies are the disposition of property—whether or not the disposition of the tremendous amount of property, machine tools, parts in process, and materials which will undoubtedly be in the hands of contractors and the Government when the war is over or when the war ends in one theater—whether such disposition should be in the hands of the services or in the hands of a central agency is a matter which requires a great deal of study and decision. What we are going to do with that problem, the disposition of which we know will have such a profound effect on the economy of the country, requires much study and decision.

That and related matters are beyond the purview of the Ordnance Department, one of the operating technical services. They may be policies which the Congress must develop, legislate for, decide, and enunciate. Others may be problems which the Executive Branch can and should handle.

The other phase of the problem is that of the administration of the termination of Ordnance contracts. Mr. Keller pointed out in his talk to you the value of the results obtained by the Industry-Ordnance team. That same teamwork is essential to the job that we have to do in administering the termination of contracts. I have not seen or heard any serious discussion which would indicate the desirability of having any other agencies than the services handle the problem of terminating the contracts—of taking down the structures which were created to do the magnificent production job that has been done for the winning of this war.

Today, the framework for taking that structure apart is built around the organization which put it together. The Ordnance Department has the responsibility for taking that structure apart—for terminating contracts. The efficiency with which that is done, of course, depends on the nature of the organization that is to handle that matter.

The Ordnance Department to date has had the responsibility for terminating over 6,000 contracts. Of those, over 4,500 have been completely and finally settled with industry, and to date we have a backlog of about 1,500 contracts. That sounds like a very great number of contracts, but when you consider that the Contract Section in the Ordnance Department last year processed over 85,000 formal contracts, you can realize that a load of 1,500 contracts is not too great for the Ordnance Department to handle.

Undoubtedly, the Ordnance Department is the organization to do the job. There has not been created and there is not in prospect the creation of any special group or special organization to handle terminations. It is not a function which requires or can be efficiently performed by the creation of a separate, new organization.

So in dealing with matters relating to the termination of contracts, the contractor will be met by and deal with exactly the same individuals, in the same places, that he dealt with when the Ordnance Department wanted him to do the things necessary to produce the goods we needed.

We must recognize, however, that there is some time lag to be expected as normal between the date of the issuance of the notice of termination and the final execution of the supplemental agreement terminating and paying the contract. We do not yet know what that period is or what it should be normally; that will come by experience. We do know that some cases are going to take far longer than others. We know that a case of a contract structure which was created to do a complicated job and turn out a complicated item—which called for the formation of a group of contractors, starting with the prime contractor and going down through several hundred subcontractors and fanning out into thousands of sub-subcontractors—is going to take time. It took time to create the structure in the first instance, and it will take time to terminate it soundly and fairly.

We must strive to make that time as short as possible; that is where industry plays its part. Your half of the job in this Industry-Ordnance team is in solving that problem.

WE have been very concerned about the 1,500 cases that are over 6 months old, and efforts have been made to find what factors are involved in extending the time. We sent our men to the districts; we called upon the districts to tell us what the reasons were, and we find that in 43.7 per cent of the cases the time factor extension involved the failure of subcontractors to submit their claims; in 25 per cent of the cases the time factor involved the audit or verification of those claims on our part; and in about 21 per cent of the cases the prime contractor failed or refused to submit his claim. The question of audit and verification is something that is within the control of our half of the team, and we propose to do something about that.

We can do something now about the subcontractor's claim and the prime contractor's claim. The most, however, that we can do is to urge the contractor, in each case, to get in his own claim and to insist that he receive his subcontractor's claim. We can make sure that the contractor and subcontractors understand thoroughly how that claim must look and of what it can be composed, but that is about all we can do. The contractor must prepare his claim and the prime contractors must insist that their subcontractors prepare and submit their claims to them. So I bespeak you, the members of the Army Ordnance Association, if you are prime contractors, to use every effort to prepare your own claims and to use all your powers of persuasion to have the subcontractor get his claim in so that we may take this complicated structure apart quietly, speedily, soundly, and fairly to all concerned. On the prime contractors rests a grave responsibility to the subcontractors that those claims come in.

The Industry-Ordnance team has worked very effectively in production, in creating the organization to do the production job. Let's continue that same spirit and that same coöperation to get the termination job done.

Colonel Duffy is chief of the Legal Branch, Office of the Chief of Ordnance. This is an address delivered at the Production Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Military Explosives

Ordnance and Industry Were Ready for World War II

E. B. Yancey

AT the outbreak of hostilities in Europe in 1939 the military-explosives capacity in this country was negligible. However, due to the farsighted policies of the Ordnance Department there were available, for use in the expansion program of the more important military explosives, processes which had been operated on a production basis and a nucleus of trained personnel.

Consider, for example, the case of smokeless powder. Hardly had the echoes of the guns of World War I died away before the Ordnance Department, realizing the shortcomings of the propellants then in use as brought out by combat experience, in 1919 asked for industry's coöperation in the development of a propellant which would be less hygroscopic and produce less muzzle flash. Work was started immediately, and in 1925 a greatly improved propellant was ready for plant-scale production. As time went on, continued development work resulted in further refinements and improvements, so that when expansion became necessary both the process and the product were well established.

In line with the Ordnance Department's customary policy, in 1925 a survey was made of the military-explosives industry, in which the capacities for the various types of explosives required were checked and the possibilities of expansion in case of need thoroughly investigated. The data collected were checked from time to time, and in December 1936 the Ordnance Department called a meeting in Washington to which representatives of the explosives industry were invited. At that meeting the requirements of propellants and military explosives under the War Department General Mobilization Plan were discussed. It was brought out that the time required to create and put into operation the new facilities needed to produce the propellants and military explosives called for under the plan could be greatly reduced if the Government would organize a small engineering staff and prepare, with industry's coöperation, unit plans for standard operating lines. At least six months' time could be saved by having such plans available on M-day. It was suggested further that, if possible, there be accumulated a reserve of specialized equipment difficult to obtain during an emergency.

Little time was lost by the Ordnance Department in acting on the points brought out in the meeting. In July 1937, there was established at Wilmington, Del., a branch office manned by Ordnance specialists to collaborate with the explosives industry and others in developing plans which would embody the latest ideas in equipment and plant design for the manufacture of propellants and military explosives. Through the efforts of this Wilmington office the Ordnance Department also built up a specialized equipment reserve. The value of this foresighted policy in meeting the later emergency cannot be measured in terms of money.

Mr. Yancey is general manager of the Explosives Department, E. I. du Pont de Nemours & Company. This is an address delivered at the Ordnance Production Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Beginning in 1937, the existing facilities of the country, both Government and privately owned, were run at full capacity to build up reserves of propellants and military explosives. By the time hostilities began in Europe, it was realized that these reserves, particularly in the case of smokeless powder, were entirely inadequate. In the fall of 1939, the Ordnance Department began to lay plans for material increases in capacity in the principal propellants and military explosives. Prospective plant sites were optioned, the building up of equipment reserves expedited, and prospective manufacturers mobilized.

With the acceleration in the tempo of the war in Europe in the spring and early summer of 1940, the machinery of procurement began to go into high gear. Starting with smokeless powder and closely followed by TNT and tetryl, with accessory intermediates such as ammonia, DNT, diphenylamine, and dimethylaniline, the Ordnance Department placed contracts for facilities which were to be owned by the Government and operated by industry. The initial contracts were followed almost immediately by supplements for increased capacity.

It is to the credit of both the Ordnance Department and industry that the new facilities were constructed in most cases in record time so that by December 7, 1941, the capacity for propellants and military explosives was eight or nine times that in existence in 1939. Additional facilities were under construction and still others were in the negotiation stage. When the capacities of the facilities in operation and under construction reached the goals set by Ordnance in line with projected General Staff requirements, the totals in the case of the principal products were from thirty to over one hundred times the 1939 capacities, and deliveries were being made as needed and on time.

Meanwhile the technicians had not been idle. Consider for a moment TNT, tetryl, and smokeless powder. Prior to 1939, there was in existence in this country only one small commercial TNT plant. Its capacity per line was rated at 33,000 pounds a day. It was recognized that by further research and development work there were great possibilities of increasing the production per line. Obviously, however, when the need for new facilities arose, design and construction could not await further development work, and, furthermore, a thoroughly demonstrated process was the only acceptable one on which to base design.

THE first Government TNT facilities were built from the accepted design, but, before the first of the new units had been placed in operation, further development work on the existing plant had demonstrated that the capacity per line could be raised to 40,000 pounds a day. The minor alterations necessary were incorporated in the new facilities under construction. Time went on, and early in 1942 further changes in operating procedure at the "guinea-pig" plant brought about additional increase in capacity to 65,000 pounds a day. This improvement came in time to be incorporated in a number of plants under design and construction, and, in addition, existing plants were changed over at comparatively minor expenditures. The result was a saving of over 40 per cent of the number of lines originally planned and upward of $80,000,000 in construction costs, with corresponding savings in time and man power. With additional experience, production per line has gone up steadily until now production rates as high as 106,000 pounds per line have been attained.

The experience in tetryl parallels to a lesser degree that in TNT. The 1939 production figure of 2,500 pounds a day per line has been increased by means of research and development work so that now an average capacity of 5,000 pounds a day per line is easily attainable. This has resulted in the cancellation of a considerable number of lines previously thought necessary and a monetary saving of approximately $10,000,000 in construction costs.

In connection with the smokeless-powder program, initial designs were based on a standard line having an estimated daily capacity of 100,000 pounds. In the case of the first plants built, liberal allowances were made in equipment installations to be sure that the estimated capacities would be attained. In view of the necessity of using inexperienced personnel, this precaution was well justified in order to make sure that the needs of the armed services would be met. As operations proceeded, smokeless-powder manufacturers were able, by modifications in manufacturing cycles and unit changes, to increase the output per line so that it eventually reached 150,000 pounds. This allowed the Ordnance Department to curtail materially the smokeless-powder construction program with a saving that might easily reach $200,000,000 aside from the saving in critical materials and man power needed for other projects.

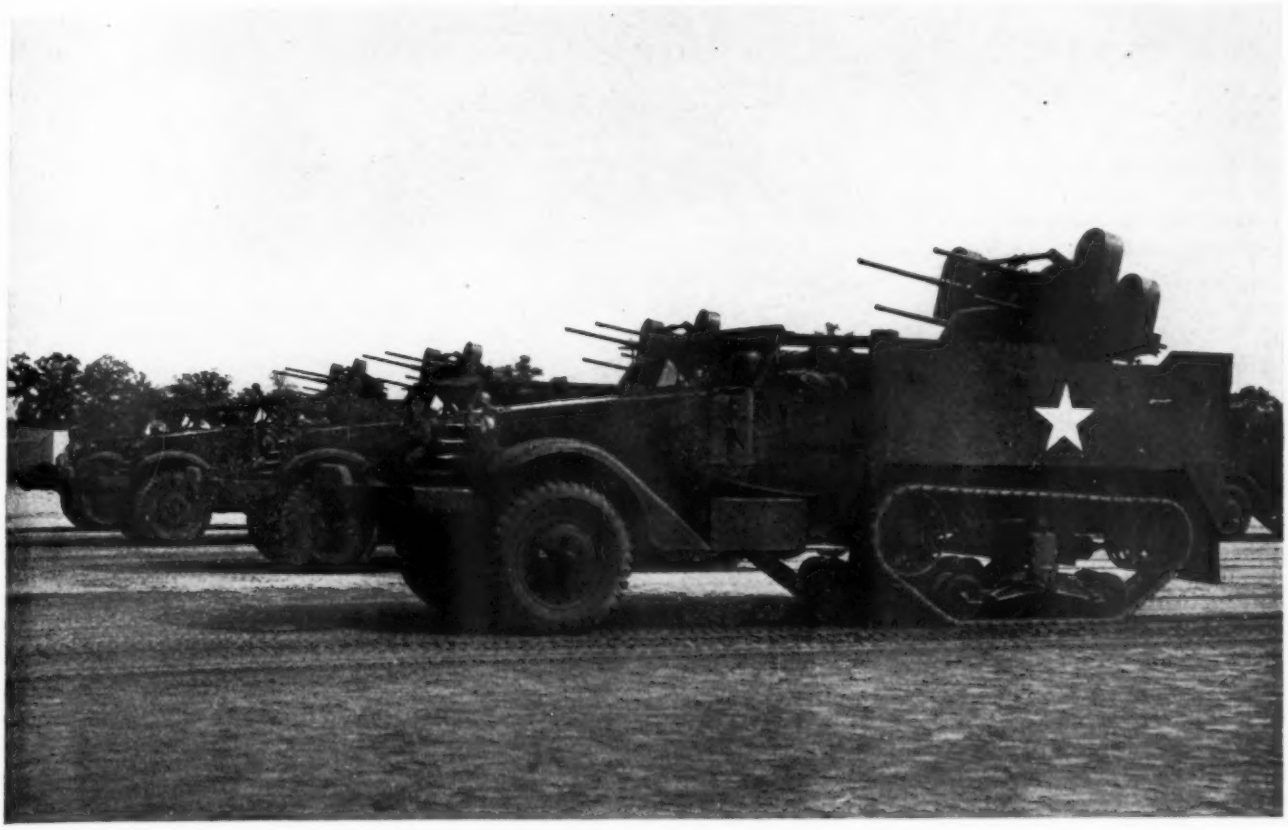
REALIZING that over twenty years have passed since the first World War, it might be well to mention a few of the benefits the military-explosives program in this war has derived from research in peacetime pursuits. The fixation of atmospheric nitrogen has made possible the development of the ammonia-oxidation process for producing nitric acid, thereby making us independent of imported nitrate of soda. The improvement in processes for producing wood pulp and the development of a satisfactory method of handling the nitration of wood pulp have made available, to augment a critical shortage of cotton linters, a satisfactory raw material for nitrocellulose at a saving, based on current production, of some $20,000,000 a year.

The development of a new method of recovering solvent in the manufacture of nitrocellulose smokeless powder has led to the release of millions of gallons of alcohol capacity a year to the synthetic-rubber and other important programs, and has effected a saving of over $20,000,000 a year. The Ordnance Department has sponsored the important development of synthetic toluol without which it would not have been possible to meet the requirements for TNT.

Of course, little publicity can be given to the research work in the military-explosives field which is being carried on under the auspices of the Ordnance Department by governmental and industrial organizations. Many important developments have been perfected and others are nearing completion. It suffices to say that there is little fear as to the ability of the American technician to outguess and outsmart the enemy. In the explosives field, as in other phases of this global war, he has continued to keep pace with anything the enemy has been able to offer and no doubt has a few surprises which will be disclosed in due course.

The explosives industry is glad indeed to have been associated with the building of our country's giant war machine which, in collaboration with our allies, will inevitably crush the Axis powers. When the history of this trying period of our national existence is fully written, it is our hope that the Ordnance Department will take a place commensurate with the all-important part it has played in the march to victory.

The "Wasp Wagon"—New Antiaircraft Weapon



The multiple-gun motor carriage (M16 made by White Motor Company, M17 by International Harvester) is proving the bane of low-flying enemy aircraft. It consists of the Maxson armored turret, mounting 4 caliber .50 antiaircraft machine guns, on the half-track truck, combining intense firepower with high speed, maneuverability, and cross-country mobility.

Ordnance Service in the Field

The Problem of Maintaining the Army's Combat Equipment

Brig. Gen. Julian S. Hatcher

NO other division of the great Ordnance Department calls to mind such distant horizons or such limitless opportunities to serve as does the Ordnance Field Service.

We feel justified in the high pride which we possess that our preparations generally have met troop demands, although the early calculations of requirements had been based upon the immediate possibility of a defensive war. An offensive global war was then only an eventuality.

The transition during the twenty-five years since World War I from a world with comparatively little motorized equipment to almost universally mechanized transport thrust new problems upon armies. These called for pioneer courage and keen judgment in estimating probable rates of required replacements to maintain types of equipment with which industry had had little or no commercial experience to aid us in calculating needs.

The factors of replenishment spare parts for maintenance became further complicated by the distances of points of demand from sources of production. Here, for once, distance did not lend enchantment! The ravages of the diversity of climates where battles are being fought caused effects upon mechanized equipment which testing laboratories could not conjure and created exceptional preservation problems. If these had not been swiftly and effectively overcome, the capacity of our American industry to produce sufficiently to meet replenishment demands might have been more greatly overtaxed than is currently the condition.

Supply, the Army has learned, is circumscribed by availability of raw materials, production capacity, and civilian man power at home. On the other hand, the demand from theaters of war may be, and often is, unlimited. The strategy of military operations alone determines demand—and rightfully so.

In our preparatory period at home we learned that stock control, or—to use a more familiar term—rationing, was the means of adjusting supply levels to demand. Experience overseas may not have yet reached the stage where stock control is possible. It may have to be the next step if industry is to be required to produce the enormous amount of matériel which it has already poured into Ordnance depots and from which Ordnance Field Service has shipped to ports of embarkation astronomical quantities of major items and spare parts which the ports are responsible for delivery to the using troops overseas.

Converted into tonnage, the Ordnance expenditure for spare parts since war began represents 1,500,000 tons. To move this tonnage to ports of embarkation at one time would require 75,000 freight cars, or a train 710 miles long. Such a train would have the first engine in New York City and the caboose at Dayton, Ohio. It would require 1,000 locomotives to pull the train.

What is inside some of this tonnage? Let us consider half an ounce of it—a worm gear from an antiaircraft fire director. It is carefully machined to the ten-thousandth of an inch. It must be packaged and handled with extreme care. (There are 4,000 to 5,000 parts of this class in fire-control equipment.) A measuring wedge for the condenser of a standard antiaircraft range finder costs $200. It is so delicate it can be destroyed by touching it with the finger, dropping it a foot in its package, or shipping it packed in the best prewar commercial method. Minute but fragile optical prisms and lenses and mainspring housings, hairsprings, and second hands for watches make more trouble than tonnage. All these are issued as spare parts. They require more work in handling than do parts one hundred times their weight.

ORDNANCE general supplies represent only about forty-nine per cent of the total tonnage handled monthly by Ordnance Field Service. Ammunition represents fifty-one per cent of the tonnage moved in and out of forty-five Ordnance Field Service depots. An average of 712,236 tons of ammunition are received in and shipped from Ordnance Field Service depots every month, and this amount includes sufficient bombs to assure Hitler and Tojo that several tons can be dropped on them every minute of the day and night from now on.

The combined area required for these vast field-service operations is 480 square miles. This is greater than the combined areas of Boston, Pittsburgh, Detroit, St. Louis, Cleveland, Denver, and San Francisco. To conserve man power, this tremendous field-service operation has been successfully carried on with 36,167 fewer civilian personnel than were employed as of May 31, 1943.

The mission of the Field Service Division is to store and issue ordnance matériel; to inspect, repair, alter, and maintain ordnance matériel in the hands of troops and in storage; to formulate spare-parts policies and, upon their approval by the Chief of Ordnance, to be responsible for their execution.

The Field Service Division receives matériel as released by the Industrial Division and stores it preparatory to issue. The Executive Branch of the division reviews recommendations for assignment of Ordnance units, compiles the Ordnance section of tables of organization, adjusts basic-allowance tables for ordnance matériel, and supervises salvage and scrapping of such matériel.

When orders are issued by the General Staff for the activation of troops units, such orders filter through the War Plans and Requirements Branch (Ordnance staff branch), and the Ammunition and General Supply Branches of the Field Service Division are authorized to issue a list of matériel to the activated units. These branches then issue the authorized equipment or, if not available, authorized substitutes therefor. The issue of matériel to overseas depots and units is also made by these branches as authorized by higher authority. Planning activities are coördinated by the Plans and Operations Branch which also controls space for storage and originates plans, drawings, specifications, and estimates for the general activities of Field Service establishments.

General Hatcher is chief of the Field Service Division of the Ordnance Department. This is an address delivered at the Ordnance Field Service Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Distribution of Replacement Parts

Adaptation of Industrial Practice to Military Requirements

Fred C. Bahr

THE motor industry has always been confronted with the problem of supplying replacement parts at the point of need when needed and doing this economically. This means a structure for distribution. It means the simplest possible system of operation. It means that the distribution system must be supported by intelligent and rapid communications. It means that both user and distributor must have a thorough knowledge of transportation and the time it takes. It means that all must have adequate parts-application information. It means trained personnel, and, above all, it means that there is no fixed formula to do the job but rather an everlasting task of administration, analysis, and training.

Industry, within commercial limitations, has experimented with this problem for many years. It has made many mistakes and has had to learn the hard way. As experience accumulated, industry learned, among other things, that no one could sit at a desk and plan distribution from the inside out. It learned that it is the users who control what has to be produced and distributed, and the competitive energy of the industry developed the pipe lines through which this supply of parts flows. It learned that the competitive efficiency of civilian motorized transport depends on the efficiency of the replacement parts supply. Without adequate parts supply, the very nature of this kind of a transport system would wither.

Today, the Army is facing the intricate problem of maintaining great numbers of motorized mechanisms of war. Therefore, continuity of supply at the point of usage is imperative. Add this supply to the great variety of war materials, and it all represents a huge transport problem of getting equipment and supplies to the various theaters of operation and keeping this equipment in action once it arrives.

The automotive industry has been unconsciously preparing for war with every truck, tractor, or passenger vehicle built. The constantly refined technics of engineering, planning, production, distribution, maintenance, and supply have laid the groundwork for the record of manufacturing achievements since Pearl Harbor which have by no means been confined to one industry. The whole structure of industrial America has risen to the accomplishment that war demands.

The skills acquired through long, hard experience were translated into production for war through the energy and ingenuity that were in this industry. Keen competition within the automotive industry had seen to it that the "know-how" and "power-to-do" were essential to competitive commercial existence.

Army Ordnance was quick to recognize and enlist industry's ability to concentrate on an objective, and the Army's program of parts procurement and distribution has been so influenced. From time to time we have been asked to review certain Ordnance parts procedures. It has been reported to us that these documents included some of the best thinking of industry. Nevertheless, and regardless of their merit, we feel that it is sometimes unwise for us to express our viewpoints on them purely in the light of commercial experience, because they are inevitably tied in with military operations, the details of which we are not in a position to know even though they may fundamentally follow current commercial practice.

Consequently, it is our firm belief that it is entirely practical for the Army to follow a general structure of distribution that closely parallels commercial parts practices, but that neither time, the urgency of war, nor the peculiar conditions of war will permit the "pin-point" controls and finesse that are necessary to commercial operations because of the business economics of investment and profit.

FUNDAMENTALLY, there isn't any mystery in this business of distribution, but, although its principles are simple, its execution is intricate. The principles involved in any distribution system follow the same general pattern and include supply lines and a storage system to take up the slack of usage, issue, and procurement. With replacement parts, however, whether military or commercial, there is a significant difference in that they have no retail market value whatever except to replace similar parts that have been worn out, broken, or lost.

Another marked difference lies in the multitude of parts that have to be handled for a variety of vehicles and the fact that they are only of value to replace a part of the same part number for a certain function in a particular make, model, or type of vehicle. In other words, "parts are not parts" like "beans are beans." In distributing beans to hungry soldiers, the beans are all alike and the soldiers all eat beans whether they like them or not. A replacement part, however, may be any one of a million different part numbers that have to be supplied and carefully identified and directed to a specific destination for a particular function in a particular make, model, or type of vehicle. Industry has learned that this inherent complication has a tendency to lead to the sin of magnified systems. I mean the tendency to try to pile system on system to solve complicated problems until the entire structure becomes so bogged in system that the primary function of effective distribution lags toward chaos because of its own complexity.

We have learned from bitter experience the necessity of keeping everything as simple and to make as few changes in system as possible. Our organization is constantly studying procedures and methods by which our efficiency may be improved through simplification and abandonment of operations that may produce something nice to have but unessential in the accomplishment of the objective.

Here again, an important difference between commercial and military parts practice is emphasized. History, in the case of commercial operations, is a fairly reliable guide to future usage and consequently to the various steps of distribution stockage. In the military, however, actuarial studies of past usage developed during wartime cannot possibly determine future requirements accurately.

Mr. Bahr is vice-president of Chrysler Corporation. This is an address delivered at the Ordnance Field Service Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Signal Corps

AUTOMOTIVE EQUIPMENT USED IN A MOTORIZED DIVISION

Left to right: 4-ton prime mover with 155-mm. howitzer, 2½-ton truck, 1½-ton truck, ½-ton weapons carrier, ½-ton reconnaissance car, ¼-ton reconnaissance car (jeep).

In commercial practice, careful operation by a time-developed system with progressively simplified procedures spells success, but what fixed system in the military setup can accurately forecast the variables of losses from sinkings, combat, parts fatalities from difficult terrain, abandonment of supply dumps, etc.? Hence, it would seem that the military must necessarily be guided by the philosophy that war is essentially wasteful and that it is better to have too much than not enough. It would also seem that the military should operate its system of parts distribution toward the end of always maintaining a sufficiency of parts at all operational points close to the front, even at the risk of oversupply.

As we see it, the need for the "inventory hump" in military-parts distribution to lean toward the point of usage is much more pronounced than in commercial practice. In the commercial field, the range and amount of parts stockage at each of the many points of parts installation depend largely upon the mechanical functions that are performed by the individual points of installation.

For example, and speaking very broadly, the corner gasoline station is usually prepared for the installation of a few simple parts such as lamp bulbs, spark plugs, etc. Consequently, the parts stocks of these service stations are restricted accordingly. In contrast, there are the general-repair shops of large dealers, garages, and fleet owners which are usually prepared to install practically any type of part, and consequently they stock and procure accordingly.

This means that parts stockage at all points of installation is inseparably related to the specific mechanical functions that the individual repair shops perform on specific types, makes, and models of vehicles. However, the mechanical functioning of a commercial repair shop is a matter of choice by the individual service station depending upon market, knowledge, desire, equipment, and capital, and it is supported by close-at-hand reservoirs of parts from which to draw running needs or to replenish its stocks. Furthermore, it has at its disposal easy and rapid communication and transportation.

Such a well-ordered state of affairs cannot be relied upon by the military. The constantly fluctuating demands of combat zones and the time-distance factor involved in supplying each theater of operation from the central United States reëmphasize the importance of maintaining a much greater proportion of material in what we would call our major redistributing points overseas and less in our domestic warehouses.

Leaving that subject, there was a lesson we learned the hard way that may have some value to Ordnance, although it is difficult to draw conclusions from it. We started out with a mammoth central operation where it was practically certain that all orders could be filled with a minimum of back-orders. Unfortunately, the operation was so big that it was practically impossible for even our trained personnel to digest its intricacies. Furthermore, transportation time to users was too great, and the resultant overload of emergency orders made the whole concept impractical.

FINALLY, a national decentralized distributing plan was evolved for approximately one-fifth of the items that constituted the bulk of the movement. Supporting this was a main base for the supply of all other required items and the replenishment of the key points of distribution. Through such procedure, the job as a whole was reduced to segments, no one of which was too extensive to be assimilated by the organization to which each was assigned.

In conclusion, our limited observations, as they relate to parts distribution for the war effort and in the light of some of industry's experiences, may be quickly summarized something like this:

1. The addition of any new or complex distributing system should be subordinated to the refinement and simplification of the existing system for the immediate job of getting the supplies to the front and keeping the front supplied.

2. Keep the "inventory hump" of available supply leaning toward the point of usage in combat operational theaters.

3. Limit the individual pipe lines of supply to a class of material that is easily within the comprehension of the operating personnel.

4. Keep in touch with the ever-changing conditions at the point of usage through the direct liaison of qualified personnel of sufficient standing or rank who can get and transmit the facts.

5. Keep a continual educational program going with all personnel involved in any phase of distribution so they will know how to interpret parts requisitions and identify and locate parts for specific makes, models, and types of vehicles.

Weapon Maintenance in Battle

Impetus of Supply Must Be from Rear to Front

Maj. Gen. Charles L. Scott

LET us consider briefly some of the difficulties we are going to have in keeping our transportation rolling—difficulties I have encountered in my practical work and during my five months' observation of the British campaign against Rommel in Libya. I am certain that we cannot overemphasize proper operation, maintenance, provisions for spare parts, and replacement requirements for complete vehicles.

As efficient and capable as our industry is, our factories, engineers, and our shipping cannot keep us supplied with vehicles at the front unless the using troops operate them reasonably and care for them conscientiously. It is regrettable that many officers and soldiers have to go over and get blooded in action before they get a proper viewpoint on this important subject. Some of them drive too fast, lose tools and spare parts, neglect their vehicles, and, as a result, bog down in battle and then get killed. I saw a letter from a young soldier at the front written to his mother. I have given this letter widespread publicity among all officers and men with whom I have come in contact. This man said in effect:

"Our lives revolve around our half-track vehicles. When we first hit Africa, too many of us drove too fast, particularly across country. We broke springs, bent axles, got stuck under fire, lost our tools, and thought we were too tired to take care of our vehicles. Many men paid with their lives for this neglect. Now my squad never lets our vehicle out of its sight. We work on it at every opportunity; we steal to keep it going. If any one drives it carelessly, not just the car commander but the whole crew gives him hell. We know that to keep this vehicle in shape and in operation is now a *life and death matter* to all of us."

It is my experience that we can get, both in this country and usually in an active theater, plenty of big assemblies such as engines and transmissions, but that the thousands of little parts needed to keep the vehicle going in the company and battalion are difficult to secure quickly even in this country and particularly at the right time and place in combat. It is vital to keep the little screws, nuts, bolts, gaskets, track links, carburetors, spark plugs, wedges, etc., on hand in sufficient numbers where they are needed. Ordnance depot companies will need to be highly trained in sorting, cataloguing, and supplying these small items promptly, and units must keep them on hand.

This impetus of supply of parts must be *from rear to front*. I saw this principle properly and beautifully applied in Libya by Major General McCreedy, who was Armored Force officer for the Middle East. He and his staff rode the front line during battle to see what was needed for tanks and other vehicles. When this officer found out what was needed, he either radioed or flew back to Cairo, at times put them in a plane, and got them up. Certainly, he did as much as any officer in the Middle East to preserve the transportation which finally got back to the El Alamein line and stopped Rommel there. I repeat, the commander of any rear maintenance echelon needs to go forward to the unit he supplies, even to the battle line, and see that the spare parts, tools, and other items of equipment needed are provided at the right time and right place. He cannot wait for requisitions to come back after the vehicle has been disabled—he must anticipate needs.

WE need to devote considerable attention to tank transporters, which are inseparably connected with maintenance. These tank transporters must go forward with completely equipped tanks and tank crews and bring back third- and fourth-echelon jobs. I saw in the Middle East many tanks sent forward in this manner and delivered at a critical point by transporters which picked up and brought back other tanks which surely would have been captured by the enemy or would have had to be destroyed. The saving was tremendous. This supply and rescue work saved the day in this campaign.

I am a great believer in the expenditure of matériel to save lives. If you attack with a thousand tanks, get where you want to go with one hundred, and carry your infantry forward, you will generally win the battle. Our experience is that for every tank knocked out only twenty per cent of the crew is lost. So if you lose 1,000 tanks you will save enough crews to man 800 replacement tanks. If you win the battle, you can probably pick up 80 per cent of the tanks knocked out by the enemy. To illustrate what I mean, the British used a 300 per cent replacement of tanks in Libya, and because of this replacement were able to stop Rommel on the Alamein line. Rommel, too, had over 200 per cent tank replacement, and, in my opinion, was able to defeat the British at Tobruk by his willingness to sacrifice this matériel.

I am sure this war will go down in history as a "mechanized war." We have produced superior mechanized equipment. We must know how to operate it, stress its maintenance, provide adequate spare parts, sacrifice it when called upon to do so, and then replace it promptly. This procedure will save thousands of human lives—and lives, after all, will be the only irreplaceable losses this Nation will suffer in this terrible struggle.

EDITOR'S NOTE.—General Scott, in the January-February 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 136, p. 67), wrote as follows: "I cannot stress too strongly the necessity for providing well-trained maintenance units and adequate spare parts which are required in an active theater. Nor can any of us do too much to assist the Chief of Ordnance in his efforts to supply these essentials. The lack of maintenance units and of spare parts was one of the greatest handicaps facing the commander in chief in the Middle East. For example, a large percentage of both tanks and combat aviation present in this theater were not available for use in battle due to inadequate maintenance. . . ."

General Scott is Commanding General of the Armored Command, Fort Knox, Ky. This is an address delivered at the Ordnance Field Service Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Spare Parts Supply

A Proposed System for Simplifying Motor Vehicle Maintenance

Irving Babcock

THE Ordnance supply system is of long standing, and it has been changed from time to time as the result of experience. Much has been accomplished to improve it since the beginning of the war, but certain serious difficulties still exists which are perhaps due to the lack of adequate or sufficient administration rather than to any major defect in the system itself. It is believed that these difficulties can be improved without basic changes in the original Ordnance procedure.

During the past two years it has been necessary not only to build major, filler, and supply depots for camps in the United States and overseas but also to educate and train sufficient personnel to man and operate them. As long as the war lasts, and as long as the Army has the problem of supply and distribution, it will be necessary to continue the education program for new Ordnance men. Therefore, a review is advisable for the men who have already received this education in order to keep them up to date on current procedure.

It has been found in business that one can hire the best salesmen, shop superintendents, and foremen or that they can be trained, but in either case the result of their efforts is only as good as the checking of them. In other words, a check should be made of the work of every department at short intervals without notice.

The present method of ordering parts involves: (a) concurrent spares, (b) second-year spares (to be replaced by quarterly ordering system), and (c) replenishment parts. Of the more than fifty different makes of vehicles, there are approximately only six makes which the Army buys in sizable quantities. It is recommended, if the present system of ordering parts is continued, that certain depots and filler depots on both coasts be assigned to each of these six major vehicles. This would reduce the total number of parts handled in each of these major depots and also would aid the personnel to become more familiar with the individual manufacturers' vehicles.

Concurrent spare parts for the other forty-four makes of vehicles should be assigned to one depot on the East Coast and one on the West Coast with filler depots supporting them. This would eliminate those parts from all other depots and would simplify all work pertaining to the maintenance of records and checking with suppliers and overseas forces.

Second-year spare parts should be stocked in the same depots as concurrent parts, with the same recommendation as to the warehousing of these parts. In order to reduce forward commitments for material and its processing, it is recommended that the Army adopt the quarterly ordering system at the earliest possible date, letting it take the place of second-year parts orders. These parts requirements should be given six to nine months' lead time where conditions warrant. The amount of lead time must be flexible because it depends on the availability of man power and facilities, and this should be set by agreement between the contracting officer and the prime contractor who should review the list every six months, if not quarterly.

Replenishment orders should be restricted only to replenishment stocks which had been inadequately estimated in concurrent, second-year, or quarterly orders. Eventually, the quarterly ordering system would eliminate any necessity for the replenishment ordering system.

Emergency orders should be issued only when parts are not available either out of concurrent or replenishment stocks, and they therefore should carry the highest priority. The prime contractor should have the right to divert material from concurrent, second-year, quarterly orders, or replenishment orders on hand without affecting his concurrency. Such diversion would be replaced when material became available.

Stock records at depots should be continually spot-checked to ascertain if the posting of receipts and shipments are up to date. If shipments for operating camps in the United States or overseas are used as a base line for the determination of usage, any transfer from one depot to another should be clearly indicated in order not to distort actual usage.

Physical inventories are only taken to verify accuracy of stock records and, therefore, they lose that advantage if posting receipts and disbursement records are not up to date at all times. Realizing the enormous tonnage and quantity of parts received and shipped out of depots, it is virtually impossible to stop operation at a depot long enough to take an accurate inventory of the entire stock. It is believed possible to develop a group of men who would have the specific duty of continually taking the inventory of a few parts each day in order to correct card records. Over the period of a year, this progressive inventory checking would accomplish the same results as a complete inventory taken by shutting down all operations. This group should not only check the physical stock but also the unloading and loading docks as well as any stock in temporary location, outside buildings, and on sidings.

AN instructor should be assigned to each depot to check the work of the various departments, and he would be called to the Office of the Chief of Ordnance once a month to go over changes in procedure and specifications. Upon returning to his depot, he would advise the depot personnel of all changes agreed upon and their effective date. These would include changes in procedure, boxing, packaging, specifications, quantities of boxes, cartons, and containers which are particularly frequent at this time when prime contractors are going through the transition of changing to what is known as the 70-pound pack. As the changes in procedures decrease, these visits could be extended to one each two or three months. However, the thought is to have some one at each depot conversant with contemplated changes on the date they will go into effect and who would have the responsibility not only of passing that information on to those in the depots but also of seeing that they are carried out.

Mr. Babcock is president of Yellow Coach & Truck Company. This is an address delivered at the Ordnance Field Service Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Signal Corps

ARTILLERY PRIME MOVERS REQUIRE AN EFFICIENT SPARE-PARTS SUPPLY IN THE THEATER OF OPERATIONS

Realizing that experience requires changes in both decreasing and increasing the quantities of various parts required on the concurrent list, it is recommended that, when these quantities are changed, no change be made in the number of pieces that go into a package, the number of packages that go into a carton, or the number of cartons that go into a box under the new 70-pound pack. The prime contractor should be given sufficient latitude to balance his quantities between cycles. The confusion that exists in changing the number of pieces in the wooden boxes is alarming. Not only does the size of the wooden box change, but equally important changes must also be made in the size of the liners, cartons, individual wrappers, and packages. If the number of pieces in the present design of the 70-pound pack are listed, it will not only simplify operation for the prime contractor but also for depots both in the United States and overseas. They will know how many pieces are in a given box and will be able to stack boxes more uniformly. This will also facilitate an easier checking of inventories.

It is recommended, therefore, that Ordnance freeze the present preservation, packaging, and boxing procedure as well as the number of parts which have been engineered to go into these packages and boxes for at least the shipments scheduled for 1944.

SECOND-YEAR parts should be packaged in the same containers that are used for concurrent spares so that the manufacturers will not be expected to carry different-sized packages, containers, and wrappings, even though it is requested that they be shipped in domestic rather than overseas boxes. It is believed that past changes in preservation, packaging, and boxing procedures are as responsible for deficiencies in spare parts as shortages of materials and man power. Undoubtedly, it will take industry another ninety days to overcome its confusion and be able to settle down to the new specifications, at which time parts deficiencies will be corrected, except where man power or facilities have not been provided sufficiently to manufacture all requirements.

Vehicles in stock pools should be disbursed on the basis of "first in, first out." The reason for this is evident in the consideration of concurrent spare parts for wheeled vehicles—which are on the same basis. This is in order to have the right parts for the right vehicles at the right time. Engineering changes are being placed in effect constantly, and we have gone to great lengths to synchronize such changes with production of vehicles and spare parts in order to obtain maximum availability. Yet, all is lost if vehicles or parts do not move out of depots or pools on the basis of "first in, first out."

The maximum interchangeability of parts between makes of vehicles is limited to the availability of parts in comparison with requirements. Therefore, the greatest possible interchangeability availability would be on the six major makes of vehicles, since they represent the greatest number in the Army. Although interchangeability of parts between the six major and the other forty-four makes may be somewhat important, the availability of parts of the forty-four minor makes is limited by their small quantities. It is felt that concentration of interchangeability should be stressed between the six makes representing the Government's heaviest vehicle purchases.

It is understood that, to date, there is no reliable record of usage by part number available. Industry should supply Ordnance with a list showing quantities shipped by part number for the past two or three years which, if compared with total inventory in depot stocks, would at least show the disbursements or shipments out of the United States. This would not disclose the usage overseas or in maintenance shops in the United States; however, we believe it will show up those parts or assemblies of which the Army may have an excess stock. If these schedules could be cut within ninety days, it would not only give industry great relief on man power but we believe it also would be of great assistance in correcting the present deficiencies because of the relief on machine facilities, foundry, forge, and heat-treat capacities. Industry is as anxious as Ordnance to improve the present situation and to be concurrent on all Army requirements.

Packaging Ordnance Material

The Protection of Fighting Equipment for Overseas Transport

Herbert T. Holbrook

OUR major objective in the packaging of ordnance material has been to prepare it in such a manner that it will arrive at its destination ready for the kind of efficient use which is built into the item itself. In doing this, we also have tried to conserve ship space, critical materials, man-hours, and dollars.

Early in the war, it became apparent that the expert packaging methods employed by highly successful commercial shippers in peacetime were usually insufficient for our present needs. In peacetime, material shipped overseas was well covered with insurance, and it was also pretty well covered in other ways from the time it left the factory until it reached the point of final distribution. It was kept in covered warehouses, given preferred stowage, careful handling, and, when it got to its destination, it was picked up by trained personnel who could give it the sort of servicing that might be required in case anything had happened to go wrong. Moreover, when it left the factory, the shipper had a pretty good idea as to its ultimate destination.

Conditions in wartime are quite different. The ultimate destination of any military article is seldom known at the time it is packed. There are approximately seventy-six theaters of operation, and when an item leaves the factory it is likely to go to any one of these. It is therefore necessary and essential that all shipments be prepared for the most severe types of handling and climatic conditions that can possibly be encountered.

Our job would be much simpler if we knew, for example, that a piece of mechanism were going to the South Pacific, as we could give it the maximum in protection against corrosion, mold growth, and other things that are so deleterious to matériel in that area. If we knew that Alaska was going to be its ultimate destination, we would give it an entirely different treatment, as there are different problems of packaging materials for ultralow temperatures.

Similarly, if we knew the shipment was going to the United Kingdom, we could afford to ship it in rather large cases which would be easy to handle and which would conserve man-hours in time at the factory and in our depots. But when it gets to the United Kingdom, we don't know what is going to happen to it. We know that a tremendous amount of matériel used in our North African campaign was first received in England. We hope what we are shipping to England now is going to take another sea voyage very shortly—not so long this time—and when it does, we are going to have need for light packs that can be handled by two men—preferably by one man. We have to prepare for those things here in our factories and depots.

We of the Ordnance packaging section in Washington and those concerned with packaging in our Ordnance districts and in our depots and arsenals take our responsibility for the safe packing of ordnance matériel very seriously. Those engaged in the production and manufacture of matériel know how many hours are spent in planning and producing a typical Ordnance item and the critical materials that are needed to make it. It is a real tragedy if this matériel, labor, and the ship space required to transport a weapon prove to be wasted because the item has been improperly prepared or improperly packed and arrives at the fighting front in an unusable condition. For this reason, and because the item will be irreplaceable to the soldier when he needs it, maximum protection must be provided.

There are two other enemy powers, so to speak, that militate against the safe arrival of a package overseas. First, there are the hazards that cause mechanical damage and, secondly, those less obvious hazards that cause deterioration through corrosion, fungus growth, or termites. Although we did not fully realize it a year or so ago, we have come now to understand that protection against corrosion has proved to be just as important, if not more important in a great many cases, as protection against mechanical damage, and such protection is usually quite a great deal more difficult to obtain.

IT has been necessary to develop new methods of cleaning, preserving, and wrapping highly finished parts. We have had to do that for the simple reason that those tactics and materials that proved adequate in peacetime have not quite filled the bill in these days. In some instances, where preservatives cannot be used or where they are undesirable, we have had to develop dehydrated packs with an enclosed dehydrating agent. Such a pack, for example, would be used on the very delicate mechanism that has been mentioned, where the mere touch of a finger on the prism might cause malfunctioning. A preservative can't be used because it cannot be removed without perhaps doing a great deal more damage than would be caused by a slight amount of rust. We wrap that package in a moisture- and vaporproof material and use a dehydrating agent, maintaining a low relative humidity around the part because we know parts will not corrode in humidities of thirty per cent or less.

Don't get the idea that we are striving for packaging perfection. The package just described is used only on a relatively few items. The troops must have usable parts when and where they are needed, and a bit of rust on a muffler here or a screwdriver there is not important; but similar corrosion on the mechanism of a fire-control director, a range-finder wedge, an engine valve, or in an aircraft machine gun may be a very serious matter.

Many of our supplies—to give just a brief picture of some of the physical conditions that must be encountered—particularly bulky items, such as boxed vehicles, Lend-Lease machine tools, etc., are stored out of doors in this country, perhaps for several months before they are loaded aboard ship. When they are loaded, it is frequently necessary to stow them in a manner considerably less favorable than the packaging which would usually be followed in peacetime. We may have to put boxed material in the bottom of ships' holds; we may load tanks, half-tracks, or the heaviest kind

Mr. Holbrook is assistant to the chief of the packaging section, Production Service Branch, Ordnance Industrial Division. This is an address delivered at the Ordnance Field Service Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

U. S. Marine Corps

MODERN WAR EQUIPMENT MUST BE PACKED TO WITHSTAND ALL TYPES OF HANDLING

of equipment on deck. Accordingly, we have had to develop engineering designs for crates and boxes to withstand crushing pressures of 175 to 200 pounds to the square foot.

Most of the large items, or at least a great many of them, are deck-loaded and are subjected to the terrific pressure of sea water washing over the decks during storms. Most of the cargo is discharged overseas with ship's gear, which generally consists of slings or nets. The major portion of it, once it is unloaded, regardless of the particular theater to which it is sent, is stored in the open after it arrives at the supply base. A small percentage may be placed in temporary buildings, and a still smaller portion is covered and protected with tarpaulins.

The average shipment receives many handlings. A hundred handlings are required to get a gun-cleaning mat, a simple item that is used for cleaning rifles, from the factory where it is manufactured to a South Pacific theater.

Most of these handlings are pretty rough. One of the speakers mentioned the conditions found along the Burma Road, in the handling of ordnance material by Fuzzy-Wuzzies, natives, Arabs, and Indians. It has been a question as to which particular race of native labor handles the material most roughly, and it is a very good thing to remember that, in most cases, when a box is picked up it is also likely to be dropped. It is going to be dropped from the man's hands, pushed off the tail end of a truck, and it is going to receive much rough handling.

During the past few months, we have been glad to see the number of pictures in the press which give some idea of the numerous and varied hazards to which our overseas shipments are subjected. If you could personally observe these field conditions and examine the contents when the boxes are finally unpacked, I am sure you would not question the need for a high degree of protection.

Those are some conditions that require protection against handling hazards, but there are those conditions which cause hidden damage that cannot be seen when the box travels through a port of embarkation or debarkation but are found only when the package is finally opened. Ordnance shipments are exposed to all extremes of temperature and atmospheric conditions. In one journey, they may encounter temperatures ranging from 150 degrees above down to 50 degrees below zero. Temperature changes, in a 24-hour period, may vary as much as thirty or forty degrees in some theaters, which is, of course, an ideal condition for the formation of condensation which, in turn, quickly causes corrosion and rust.

The annual rainfall in various areas ranges from less than 2 inches to as high as 450 inches. Our shipments must be packed to withstand such conditions as well as sandstorms, snow, ice, mud, and salt spray, and it must be remembered again that when a drill press, valve, or piston comes out of the factory, we have no idea what conditions are going to be faced by that particular item or part.

PERHAPS the most damaging conditions are those that are found in the steaming jungles on tropical islands in the Southwest Pacific. There the days are hot and humid, the nights are cool, and the variation in temperature is an accelerating factor in producing condensation and corrosion. There are frequent rains, fungus growths, and termites, which are very serious problems in these areas, in addition, of course, to corrosion.

Another point that we have emphasized, but which cannot be overemphasized, is the importance of clear and legible marking, both for identification and shipment. While the situation has been improved, we are still receiving many reports from overseas on the loss or lack of adequate marking. An Ordnance field officer complained because he found that on a shipment of a number of boxes, the packing lists in the envelopes were all fifth carbon copies and completely illegible. The result was that the boxes had to be opened to find out what was in them before they could be put away.

The need for conserving ship space has also been constantly kept in mind. We have recognized that a reduction in the size of our boxes and crates means that a greater volume of supplies can be transported in the same number

of ships. As an example, the early development of the so-called twin-unit pack for vehicles, by which two vehicles instead of one are packed in a set of boxes, has reduced the ship space required for those items by thirty to forty per cent. If those figures are multiplied by the number of boxed vehicles that are shipped overseas, it is obvious that this is a great space-saving factor.

During the first four months of 1943, the chief of the Ordnance packaging section examined large quantities of ordnance matériel in most of the overseas theaters in order to check up on the effectiveness of our packing. During this trip he traveled some 46,000 miles and encountered a large variety of climatic, storage, and handling conditions. On his trip last year—and his investigations have been substantiated by subsequent reports received from competent observers—it was found that in practically every instance where the prescribed packaging procedures had been followed, Ordnance supplies and equipment were arriving overseas in excellent condition. Reports from overseas also show a steady improvement in arrival condition of ordnance matériel during the last twelve to fifteen months. Of course, minor changes in our packaging instructions will have to be made from time to time, such changes being dictated by the changing tactical picture, by shortages of packing materials on hand, and by production requirements.

The wholehearted coöperation that we have received from industry in our packaging activities has been most gratifying and with this continuing support we feel sure that ordnance matériel will reach our boys at the fighting fronts in condition for prompt and effective use.

Editor's Note.—Since the New York meeting of the Association, N. A. Fowler, chief of the packaging section, Ordnance Industrial Division, made an extensive 31,000-mile tour of the Central, South, and Southwest Pacific areas to find out whether armament, ammunition, and automotive vehicles shipped from the United States were satisfactorily withstanding frequent handling, the long ocean voyage, open storage conditions, and the high humidity that prevails on tropical islands.

As a result of this trip he found that practically all matériel, except boxed vehicles and ammunition, is now on suitable dunnage and under some kind of cover. On New Guinea, most of the matériel is stored under sheds or huts, and the balance is placed on dunnage and covered with tarpaulins. The deterioration of all ordnance stores is certain to be greatly reduced as a direct result of the improvement in storage conditions during the past few months.

The condition of practically all items received from the United States which were packed during the past twelve to fifteen months was found to be good. The need for better protection of ammunition against mechanical damage and the effects of moisture has been recognized for some time. An entire new line of hermetically sealed steel containers for ammunition is being studied. It is felt that these new ammunition containers will prove highly satisfactory in withstanding the handling and storage conditions which were observed in the field.

Steady improvement was reported in the quality of depot packaging in the States, and constant attention is being given to still further advancements. With the exception of ammunition, practically all the matériel from the United States was received in good condition. In those instances where the contrary was true, the matériel had not been prepared for shipment in accordance with present instructions. Many of these latter items had apparently been in stock at U. S. Ordnance Depots for a long time before shipment.

Australian packing of supplies for our troops should show a gradual improvement as a result of the new "tropic-proofing" program recently started by the Master General of the Ordnance, Australian Army.

The damage caused to small-arms ammunition cases by termites and rotting was carefully observed. Termite damage is much greater in Australia than in New Guinea. Rotting and mold growth are worse in New Guinea, although this type of damage is slight when cases are placed on dunnage and open-piled under cover. While this type of storage is now being provided at established bases, it is recognized that highly unfavorable storage conditions will usually prevail for possibly two or three months at newly occupied positions. From a careful examination of small-arms ammunition cases from a certain island, as well as cases stored for a long time under unfavorable conditions both in Australia and New Guinea, it is felt that the percentage of ammunition made unserviceable by termites and rotting is so extremely low that the toxic treatment of all small-arms ammunition cases would not be justified.

There is a definite need for reusable cases, especially for engines, in which to make return shipments to base shops for overhauling. Cases of this nature have recently been designed for all standard engines and for other major assemblies, such as rear axles, transmissions, and transfer cases. Since these will be used on all production items, there should always be a case available for reuse.

Numerous instances were noted where a change should be made in some detail of the packaging of individual items. These are being reported to the Ordnance packaging section for the necessary follow-up with the district officers and depots concerned.

One Ordnance officer mentioned the difficulty of obtaining sufficient supplies of silica gel for use in dehydrated packs. Quite a lot of this material is being thrown away after it is removed from packing received from the United States. Arrangements could be made for salvaging and reusing it. If this is done, extreme care should be exercised to make certain that the silica gel is completely dried out before using it again.

While in Australia, the subject of Ordnance packaging was discussed with numerous Ordnance officers. They are working in close coöperation with the Master General of the Ordnance, Australian Army, and to a large extent are specifying their packaging procedure in connection with local procurement.

Some days in Australia were also spent in conference with the Scientific Liaison Bureau, Directorate of Ordnance Production, and also with General Bevis, Master General of the Ordnance, Australian Army. General Bevis arranged a meeting with about twenty officers of the Australian Army and Air Force who are at present engaged in packaging activity which they refer to as "tropic proofing." It is felt that the exchange of information on the various phases of packaging which took place at this conference was mutually beneficial. The packaging activities of the U. S. Army Ordnance Department were outlined and numerous specific packaging problems were discussed. The Master General of the Ordnance was supplied with copies of the various manuals and packaging instructions prepared by the Ordnance packaging section, and arrangements were made for the exchange of supplemental information in the future.

U. S. Army

Our Fighting Equipment

The Design, Development, and Procurement of Ordnance Matériel

Maj. Gen. G. M. Barnes

IN September 1940 the Ordnance Department received its first large appropriation in this war. President Roosevelt had successfully urged Congress to approve an appropriation of $1,250,000,000 for the purchase of ordnance equipment and ammunition. The bell had sounded and the Ordnance research and development program, continuously under way for the past twenty-two years, for the moment was at an end. It was necessary to transmit immediately to manufacturers the information as to what was wanted in the form of detailed drawings and specifications and the quantities desired.

Most informed persons, I am sure, realize the very wide field which the Ordnance Department covers in its fighting weapons. These responsibilities include all weapons used by the Army and many for the Navy and Marine Corps. In this long list of more than 1,700 principal items and over 300,000 components are all the weapons used by the infantryman—rifles, machine guns, ammunition, grenades, mortars; those required to put the sting into the airplane—bombs, machine guns, cannon, and ammunition; the weapons of the field artilleryman—from the 105-mm. howitzer, the backbone of the Field Artillery in this war, through the various calibers to the great 240-mm. howitzer or 8-inch mobile gun; all types of antiaircraft guns, fire-control instruments, and ammunition; and the Army's combat and transport vehicles.

General Barnes is chief of the Technical Division, Ordnance Department, U. S. Army. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

This was the field covered by Ordnance in its research and development programs in peace with meager appropriations of about $1,500,000 a year. The country was saved in this situation through the existence of its well-established proving grounds and arsenals which have been research centers in their particular fields of ordnance, together with the largest and most capable industrial system in the world upon which to draw. While Ordnance often lacked funds to pay commercial manufacturers adequately, scientific, engineering, and commercial organizations contributed patriotically in helping to solve these military-industrial problems. It is a matter of record that within two weeks of the receipt of this first war appropriation, manufacturers throughout the country had been put to work on $1,250,000,000 worth of weapons of all types and had been supplied with the necessary drawings and specifications.

There were, however, many blanks in the needed equipment for the Army, especially in the more expensive types, such as large-caliber mobile guns, which had been impossible to design previously due to lack of funds. It was also fully realized that under actual combat conditions, where millions of men were using the tools of war daily, the continuous and rapid evolution of all types of weapons would be necessary. Time did not permit the Ordnance Department to expand its personnel and facilities to carry such a load. This would have been a futile undertaking.

This policy was, therefore, adopted by the Ordnance Department: A partnership would be formed with American

industry, using its scientists, engineering personnel, and facilities for the rapid development of new weapons. Under this policy, control of development would be centralized in the Office of the Chief of Ordnance, while its execution would be decentralized to American industry. The Department would use its trained nucleus of Ordnance officers and engineers to set up projects to state "what was wanted" in the way of military performance and to guide and direct the work of the commercial manufacturers, drawing upon the arsenals for technical information and assistance as needed.

The Ordnance Department always has worked very closely with our sister service, the Navy Bureau of Ordnance, and it was the further policy of the Chief of Ordnance and the Chief of the Navy Bureau of Ordnance that the two Departments draw close together in the emergency to prevent any duplications.

Fortunately, at the very beginning of the emergency, the National Defense Research Committee, under the able leadership of Dr. Vannevar Bush, was organized to mobilize the scientific talent of the Nation for the war effort. This organization made it possible for the Ordnance Department to turn over to this newly created research organization many problems, particularly those pertaining to basic research.

THIS Ordnance plan of partnership with American industry has succeeded beyond our fondest expectations. It was found early that commercial manufacturers carefully selected for different types of work could take over design problems under the guidance of the Department and that they could quickly adapt themselves to this specialized Ordnance field. What amazed many of us was the speed with which research and development projects could be completed with the great engineering and industrial strength at the disposal of commercial organizations. Today, hundreds of our new weapons, the products of these combined efforts, are on the several battlefields. It would require a long time to give an adequate review of an undertaking of this size. The design, development, and procurement of ordnance in this war by the Ordnance Department of the United States Army for the United States and the allied armies through lend-lease is probably the largest in the field of engineering that has ever been undertaken in the history of the world, involving the expenditure to date of some $52,000,000,000. Suffice it to say that today there are more than 1,000 Ordnance research and development projects being jointly worked on by Ordnance and American industry, all looking toward the perfection of new weapons. As illustrative of the rapid advance which has taken place in the development of Ordnance equipment during the past three years, a few examples have been chosen as outlined below. Unfortunately, many of the best examples are still "confidential" or "secret" and cannot be revealed.

The semiautomatic shoulder rifle, M1 (the Garand), has replaced the famous Springfield rifle, M1903, thus placing this country far in the lead of all others in this important weapon of the individual soldier. In artillery, the new 155-mm. gun represents a long step over the 155-mm. gun of the last war. Likewise, the powerful 240-mm. howitzer far outclasses previous weapons of this type. It took four years to design, develop, and make these weapons available in quantities for the use of our troops overseas. The 75-mm. aircraft cannon likewise places this country in the lead of the world in flying artillery. The 90-mm. antiaircraft gun is unmatched in any country. Lieut. Gen. A. A. Vandegrift, Commandant of the Marine Corps, recently reported one enemy plane was knocked down for each fifty shots with the 90-mm. gun. Records equally as good have been set up in North Africa and Italy. The bazooka in the hands of the American soldier who is willing to stand his ground is capable of destroying the Mark VI German "Tiger" tank. Many such tanks have been destroyed on the battlefield by this new weapon.

PERHAPS the greatest task of the Technical Division today is to produce quickly special weapons to fit spot requirements in a particular theater of war, such, for example, as weapons for jungle warfare. Our officers and engineers are working day and night to keep up with the many demands for matching weapons with the varying situations of global warfare. In this work we need the close and continuous support of the industries having strong research and development organizations and facilities. We hope that there will be no holding back or hesitation to undertake difficult engineering tasks which often do not lead to quantity production, for in this way many lives can be saved on the battlefield. We have had the full support of American industry, and we know it will not fail us now.

The Ordnance Department, from its experience in two wars, knows that the partnership method for rapid research and development is not only the best policy for this war but also is the one which should be continued in time of peace. The Ordnance Department was able, through its partnership with industry, to give our country the edge in weapons over our enemies by its production. Therefore, this same system, if continued in peace with adequate appropriations, would give the greatest possible degree of national safety. Ordnance, with all the force that it can muster, intends to strengthen this partnership with American scientists, engineers, and manufacturers for the continuous development of superior fighting equipment. In this way, our country will always have the advantage of superior weapons in any war emergency of the future.

EDITOR'S NOTE.—Writing on "Our Weapons in North Africa" in the September-October 1943 issue of ARMY ORDNANCE (Vol. XXV, No. 140, p. 327) General Barnes said:

"The important thing about the Garand rifle is that it makes each American soldier the equivalent of two Japanese soldiers as far as firepower is concerned. . . . The Japanese Army is sometimes said to be an army of men. Japanese officers teach each soldier to depend upon his courage, his tenacity, and his willingness to die for the Emperor. The American soldier is taught to have confidence in the superior firepower of his weapons and that many lives can be saved through the proper application of overwhelming firepower. The Japanese Army will go down in defeat. The German Army has come to the end of the road. No longer will powerful German armies equipped with superior weapons be able to ride roughshod over weak and ill-prepared nations. The German Army now is faced by Russian, British, and American forces armed to the teeth with the most modern and effective weapons. The German Army will go down in defeat.

"In the victories which have been won and which will be gained in the future, history will record the remarkable achievement of American industry in providing, in so short a time, not only our own Army but also the armies of the allies with modern fighting equipment through the application of American mass-production methods."

American Ingenuity

War Inventions and the National Inventors Council

Dr. Charles F. Kettering

THE National Inventors Council aims to accomplish two things. The first is to have a home office for every inventor in the country; that is, some place where he can go to discuss his problem with some one competent to advise him. Secondly, the Council sifts the suggestions received and classifies them. Through its contacts with the armed forces, it turns those which have a possible value into the right channels. It is interesting to note that the percentage of inventions which are turned over are higher through this method than we have ever seen in a single industry. This is not surprising, however, in view of the fact that every phase of the global war effort demands inventions, while in the automobile or other industries, the inventor's scope is limited.

The total number of inventions submitted goes down when the war news is good and goes up very rapidly when the news is bad. Some of the letters we get are most interesting—especially when an inventor submits his invention today and then wonders why we haven't got it on the fighting front tomorrow! Nevertheless, the plan has worked out very satisfactorily, and the members of our organization have been most sincere in giving the proper consideration to every invention submitted.

You have all seen those displays in which the relationships between various parts of an organization are indicated by ribbons running from one to the other. I would like to see an Ordnance Department exhibit after the war with little ribbons or lines running down to their different contacts in industry which have been achieved through the Army Ordnance Association. There are some people who think that there is absolutely no coördination at all between Government engineering organizations and industry. You who have been in this organization from wayback know how intimate are the contacts between Ordnance and industry, and I know that the Ordnance organization has a method whereby it can contact almost instantly anybody in the country who could be of any help in the war effort.

I wish I could speak not to you men here who know how to make things, who know how to design, who know the processes of preparation required for ordnance manufacture, but to the millions of people whose only sources of information are columnists and commentators. I should like to be able to tell them of some of the things you have worked out during this World War and before, and what achievements have been accomplished by our system of mass production that we talk so much about and which is so little understood.

As you perhaps know, Eli Whitney, back in Revolutionary days, made perhaps his greatest contribution in building for the United States Government 10,000 Army rifles. Up to that time, rifles were made by individual gunsmiths, and, when a part broke, you had to make a part for that rifle. The reason I am telling you this story is because it shows that time doesn't change things very much. Whitney took a contract to make 10,000 Army rifles in two years' time, and he planned to do it by the process of interchangeability, so he designed special tools to make the parts. At the end of the first year, he delivered only 500 rifles. Then everybody wanted to throw the project overboard. Whitney was still making machines; he hadn't completed all these machines and he hadn't gotten his pilot line running. Nevertheless, there was a terrific furor in Congress. This fellow had wasted half of his time. He should have delivered 4,000 rifles the first year and 6,000 the second, and he didn't even have his machinery completed.

Well, he took a box of parts, springs and barrels and stocks and what have you, and piled these parts before a Congressional committee. He said to Senator So-and-So, "You pick out a piece from each pile and put it over there on that table, and you, Senator, take a piece and place it on this table," and so forth, until he had fifteen or twenty piles laid out. Then, in a few minutes, his gunsmith assembled fifteen or twenty rifles and took them out and fired them.

WE went through exactly that situation in the early part of this World War. They were pouring abuse on the heads of the Ordnance Department and the manufacturers. "Where is this wonderful automotive business?" they wanted to know, among other things. It was almost an exact duplicate of the situation in Whitney's time. Once the designs are perfected—and remember, after all, mass production consists in making pieces—then we can set up the tools to make a million of those pieces, each with certain tolerances, and assemble them quickly into the finished product.

That, I think, is tremendously important, because the system will not work unless you have a coöperative organization, as you have here in the Army Ordnance Association, and, to my notion, this represents one of the most basic patterns of all the relationships between Government and industry. This is the way to keep science and industry mobilized, and I think that we now know how to do it.

It has been said, in reference to our preparations for war, that only when it looked like rain did anybody want an umbrella. During the sunny days of peace there was a difficult time getting any money to buy "umbrellas." During this period, in order to stimulate some constructive thought a little prize was offered to a group of men who would answer this question: "What would be the best means of dealing with the Axis leaders after the war?" The answer I liked the best of those submitted was this one: It said, "I don't think we should treat those fellows very badly. I think we should have a great country club someplace, where they can have golf courses and swimming pools and this, that, and the other thing. They should have a big clubhouse, with all the facilities in the world. The only thing I want to require in that clubhouse is that we have the maps of all of their campaigns up on the walls so that when they are eating they can sit there and look at those campaigns and see how damn near they had come to winning this war! I can't think of any worse punishment than that."

Dr. Kettering is general manager of the Research Laboratories Division, General Motors Corporation, and chairman of the National Inventors Council. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

The Piat—British "Bazooka"

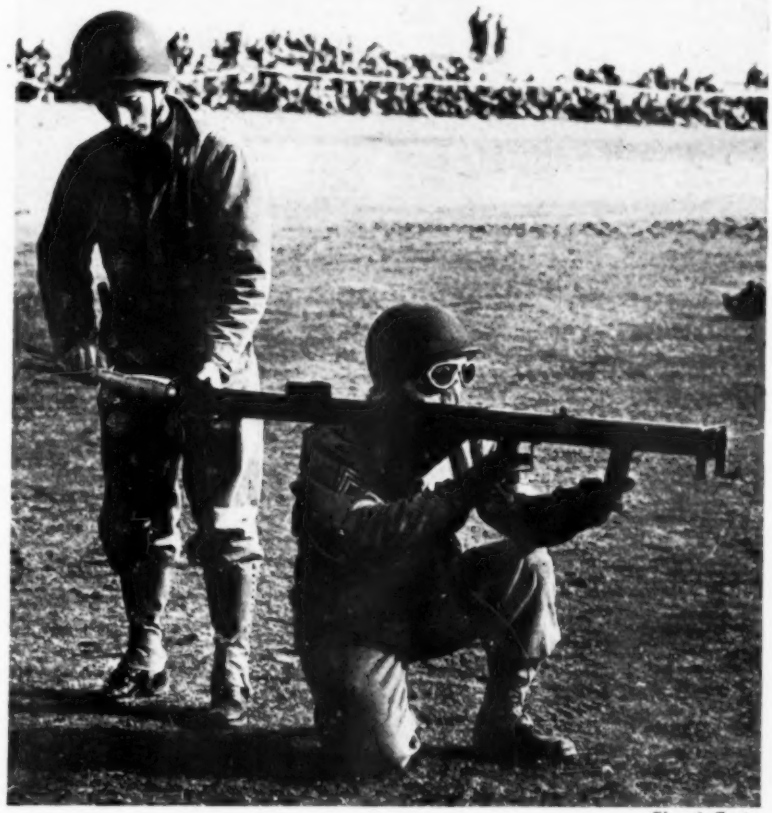
The new British 33-pound infantry antitank weapon, the Piat, fires a 2-3/4-pound bomb which can pierce about 4 inches of armor plate. A cartridge in the tail assembly propels the projectile, while a heavy spring absorbs most of the recoil. The bomb is loaded into the front of the Piat as shown above while, below, the crew is ready to fire the weapon (Acme photos).

Armament Engineering

The Development of New Weapons in Record Time

Clifford Roberts

APPLIED to the armed services, Research and Development means changes for the production line, changes for the services of supply, changes for the training camps, changes for the fighting forces, and headaches—perpetual headaches—for the research or development man who started it all. The phrase "research and development" is generally used carelessly, and I know of no definition of research or development which is universally acceptable to every one. For the purpose of this discussion, I suggest that we describe research as applying to objectives involving something entirely new as to theory or fact, and development as covering improvements or adaptations to existing theories, facts, or equipment.



Signal Corps

THE BAZOOKA ANTITANK ROCKET LAUNCHER

For almost three years now we have been very actively engaged on research and development for the armed services. We have had about fifty per cent research problems and fifty per cent development problems. We have had the privilege of working for Army Ordnance, Navy Ordnance, the Army Air Forces, the naval air service, the Chemical Warfare Service, the Office of Scientific Research and Development, and the National Defense Research Committee. However, the Technical Division of the Army Ordnance Department all along has continued to use the largest percentage of our research and development facilities. We have had problems on tanks, ships, submarines, and planes; on bombs, grenades, fuzes, and torpedoes; fire-control equipment and sights; all kinds of problems on automatic guns of various calibers; gun turrets for airplanes, ships, and tanks; chemical problems, and problems on items which cannot be mentioned.

When these agencies asked us to work for them, we, like the production industry, had our conversion problems, but they were of a different type. Rather than having to convert the tools of a plant to make tanks instead of automobiles, we had to convert the minds of our research and development staffs from thinking about the making of shoes and shoe machinery to the problems which I have just mentioned. Very few of our staff had any previous experience or knowledge of this type of work, and when Ordnance started tossing problems at us, we were faced with a sizable educational job—that of converting the atmosphere of our peace-loving shoe-machinery staffs to one of ferocity and bloody slaughter.

As the men of the Army Ordnance Department are to a large degree responsible for this conversion, I think we should give them the credit for the transformation. We did not appreciate just what was going on, but their inspiration and example certainly changed our peaceful research staff into a group whose thinking and execution are now even a threat to the imaginative thinkers of the funny papers! This condition, of course, cannot go on forever, and the day will come when Army Ordnance will have another responsibility and reconversion job on its hands. It will certainly have to go into reverse and help us quiet down our warriors of research and get them back to peacetime thinking again!

IN all seriousness, the program that the Ordnance Technical Division had for educating civilians such as we was not only effective and efficient, but it was fast and free from red tape—and, moreover, it *worked*. On behalf of our research organization I would like to take this opportunity to pay tribute to General Barnes and his staff for having handled our men and their problems in a way that caused a minimum of disruption or inconvenience even though the Ordnance Department was under terrific pressure. We have always found the men of Ordnance friendly and patient, and yet impatient when it was necessary; dreamers and yet practical to the nth degree when time was of importance.

I think the outstanding single factor which has impressed us in our contact with Army Ordnance has been the high

Mr. Roberts is director of research of the United Shoe Machinery Corporation. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

quality of their Technical Division personnel. Not only are they up to date technically, but they combine with this knowledge the qualities of tact and all-around business management ability. They also have a hard-boiled point of view, particularly on subjects presenting manufacturing and production problems. There is an old saying that no organization is any better than the people who work for it. I think the Technical Division has built on the same lines and is an outstanding organization of good men who can stack up with the best in industry. It is mainly because of this that our weapons today are what they are and why they are so outstandingly good.

From time to time, one hears criticisms of Army methods along the lines of there being too much red tape, too many lawyers, too many delays, etc. In the early days, I will confess that we were a little exasperated at times with Army methods, but we soon found that by sitting around a table the Army would meet us more than half way, and we are convinced that if anybody is having trouble of this sort today the trouble is probably not the fault of Ordnance. From our contacts with many other concerns doing the same kind of work, we find, in general, that they have had the same experience.

After proper clearance on confidential subjects, there are no insuperable obstacles between Army, Navy, Air Forces, and the National Defense Research Committee, or between the commercial laboratories in industry. It is about as harmonious a group as any large family is, but, naturally, once in a while some one gets a bellyache, which is only human, and we should not forget that all of us are working under high pressure. There are, however, some people who do not believe that the family is harmonious. All I can say to them is: God help us and the United States if we ever get a political scientific bureaucracy imposed on top of the services and ourselves, or even between the services and ourselves.

I CANNOT help making reference here to certain Senate investigations which have made a point of emphasizing the number of suggestions received by the National Inventors Council and the small number adopted by the armed services. The implied criticism is that the armed services have closed minds, no imagination, or are too stuffy to accept suggestions from outsiders. We have not found this to be the fact. We know they are more anxious to win this war than any one else is, and we know they don't care where good suggestions come from.

Unfortunately, like the armed services, in many instances we, in business, cannot take the suggesters into our confidence and tell them the detailed reasons for turning a suggestion down. We may not be able to say that we are already working on the same problem or that we propose to eliminate that subject by substituting something else, although that may be the fact. The answer very often irritates the suggester, but that is no reason for doing as some people have advocated; namely, trying out every suggestion that comes down the pike. Such a move would set back the necessary research and development work which is already behind schedule. Using Dr. C. F. Kettering's apt description of this kind of experimenting, it would amount to a lot of "self-entertainment" for a number of crackpot inventors and, without doubt, not a few politicians.

We have WPB on hand to limit all but essential manufacturing. The armed services, because of the confidential nature of these suggestions, are the only people who can properly pass on warlike suggestions.

The available chemical, electrical, mechanical, and other skilled pilot-plant personnel are as scarce as Japanese prisoners. There is a shortage of this kind of help now, and if this mass of self-entertaining experimental work was added to what is already on the books it would result in a grave wastage of man-hours and would set back the war effort.

In investigations of this kind it should be obvious to all that the technical divisions of the armed services have one hand tied behind their backs and cannot explain or defend themselves as adequately as they would like to under these conditions.

WE have learned many things which we can use to advantage in peacetime. We knew we had a number of good men, but we did not appreciate how good or how versatile they were until the Technical Division commenced to ask for the almost impossible. When all was said and done, we really did not know how to use them to the best advantage until insistence on speed pushed us into a way of doing it. We had always felt that research, in particular, could not be hurried: today we know that it can be hurried, and necessity made us find a way to do this.

One problem that we have been proud to work on is the 75-mm. airplane gun project which has been publicized recently. We believe that it will not be long before you will hear better and still more startling news in this connection. Another, the 90-mm. antiaircraft gun with its fuze-setter rammer, is an important contribution to our antiaircraft defenses, and when used in combination with that marvel of design and production—the M9 director—should make the air a very unhealthy place for enemy aircraft. Through the combined efforts of Ordnance, Sperry Corporation, and our own staff, this director has had its efficiency increased. The Marines at Guadalcanal have a fine record with the old model, but we are all confident that with this improved equipment we can expect still better performances.

This is no bow-and-arrow war, as you know; it is not a Navy war, or an Army war, or an Air war. Victory demands teamwork; not just teamwork in the production lines and various fighting services but, first of all, teamwork in the research laboratories of the country and teamwork in the technical staffs of the fighting services. We have that today, even to the point of having teamwork with our allies.

The commercial peacetime jealousies which existed between one research laboratory and another and between one Government service and another have been put aside for the duration and, I hope, forever. The cards are on the table today, face up, for those who should properly look at them. All of this has taken much hard work; yet it is accomplished, and the Technical Division of Ordnance, so far as we are concerned, has played a major part in bringing it about. Not long ago, some commercial managements looked upon research organizations as necessary evils, but I think that today research as a whole commands the respect of practically every one, because it is now realized that whether one is fighting for one's life on a battlefield or fighting for commercial existence, knowledge, as always, is power.

The commercial publicity on fire control, directors, tanks, etc., has emphasized the technical aspects of this war to a greater extent than ever before, and I think these products of the Ordnance Technical Division have done much to show the country what science can do with the proper inspiration and guidance.

Development of Weapons

Ordnance Research and Engineering for Better Armament

William J. Meinel

THE Ordnance Department and private industry working as a team have, in a comparatively short period, accomplished miracles in developing ordnance to meet modern Army requirements. Extensive research was necessary on the part of private industry in order to develop equipment to meet the exacting requirements of the Ordnance engineers. Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, early in 1942 stated that: "All we have to do is to place our problems in the hands of American industry for solution." His confidence in the ability of private industrialists to perform freely and unhampered inspired them to put forth their best efforts and resulted in remarkable achievement. His confidence was justified.

Ordnance engineers know their jobs and have supervised the design and development of matériel which, with the experience of American manufacturers, made it possible to put into the field ordnance unequaled by any other country. It was fortunate that the Ordnance Department was headed by men of vision who were ready to accept practical suggestions and changes in design that facilitated manufacture. It enabled private enterprise, which was well equipped to handle the tremendous research and engineering problems, to go to work in a modern way.

Constantly changing conditions on the fighting fronts all over the world called for constantly changing equipment. The Ordnance Department realized, better than industry, that American industry could and would meet this challenge. The many new and improved items of equipment in use today are proof of the coöperative accomplishments of Ordnance and industry.

We appreciate the many opportunities we have had to serve the Technical Division of the Ordnance Department. Fortunately, we anticipated some of the needs of our allies even before we entered this war. Several years before the outbreak of World War II, our company had established contacts abroad. During one of my visits to England, I had the pleasure of talking to many leading industrialists and bankers. There was, at that time, every indication that they would soon be faced with another war. Upon my return to this country our company decided to join with our Ordnance friends, in so far as possible, in research and development on Ordnance items. There was considerable advantage in our knowing something of the preparations being made by Germany, France, and England. For example, the United States standard 5-gallon liquid container was developed from a sample German container which we brought to this country.

In our research, we developed new methods of producing satisfactory gun barrels for our friends abroad. In Britain, gun-barrel forging facilities were quite limited. We, accordingly, developed a hot-rolled bar stock which, with proper treatment, was producible in large quantities, at low cost, and gave remarkably improved results. This blank, normalized, heat-treated, mechanically worked and stress-relieved was in every sense equal in its physical properties to the forged barrel. It machined easier and accepted a better machine finish. Furthermore, and most important, it had a longer accurate life in service. Thereafter, this barrel was never a critical item of procurement to the British and was adopted also by the United States Government for its 20-mm. cannon. The saving in dollars was astounding.

ANOTHER interesting engineering job was the development, at the request of British ordnance chiefs, of the first armored antiaircraft machine-gun mount. With the coöperation of Ordnance officers, we quickly presented a commercial design of a pedestal housing an equilibrator spring which provided for the counterbalancing of a large, serviceable shield of armor plate. Throughout the design of the mount, commercial, easily obtainable materials were used with a minimum of machining, the assembly being so simplified that a very small space along a conveyor line provided for the production of substantial daily quantities. In fact, this mount could be completely built from the raw material to the finished product with its corrosion-resistant finishes and paint in 2½ hours. This design and the production line were ready for our own Government's use when the demand arose. Both the Army and Navy are using quantities on landing craft and elsewhere. We are happy that reports from battle zones say that the lives of many of our boys have been saved behind these shields.

Still another development in this field was the new caliber .50 aircraft machine-gun mount, M3, the sole standard Army mount of this type. It embodies many new features and is of greatly reduced weight. All critical materials were eliminated, and vibration was greatly reduced. It has a wider range of fire and better maneuverability which helped the gunner more effectively to follow a fast-moving target. The gunner could stand in an upright position through the full range of firing from minus 15 degrees to 90 degrees elevation, with free vision through the gun sight at all angles.

Many outstanding engineering contributions have resulted from the joint efforts of the Ordnance-Industry team. This is a good partnership, and it should be continued after the war. This experience gained by our Ordnance and industrial engineers in working together will prove helpful in planning for the postwar period. The industrialists with whom I have had the pleasure of working plan to carry forward, with the same enthusiasm, research and development in the postwar period in an effort to increase our industrial activity to permit the employment of all our returned fighting men as well as those in Government agencies who will return to private industry. This full employment will depend in a large measure on the ingenuity of our engineers and scientists in pioneering new products and better methods of manufacture.

It is hoped that the Government will permit industry to build up a sufficient reserve so that industry can continue its scientific research and development for Ordnance as well as its peacetime pursuits in the years following the war.

Mr. Meinel is president of Heintz Manufacturing Company, Philadelphia, Pa. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Coöperation for Achievement

Joint Activities of Army and Navy Ordnance

Capt. William M. Moses, U. S. N.

IF Lieut. Gen. Nathan Bedford Forrest were living today, his famous maxim that victory goes to him who "gets there fustest with the mostest men" would probably have to be changed to "who gets there fustest with the bestest weapons!"

The best weapons can be obtained only through the combined efforts of the entire country. At Aberdeen Proving Ground a few weeks ago, Col. Scott B. Ritchie, chief of the service branch of the Ordnance Technical Division, spoke of the triumvirate of industry, science, and military services which had made possible the really magnificent developments that have been placed in the hands of our fighting forces. Without such a triumvirate, working in close harmony, the majority of these accomplishments would have been impossible.

In a large measure, the same procedure and the same arrangements apply to Navy ordnance, and Army ordnance alike. Within the Navy Department, the Bureau of Ordnance occupies a position corresponding to that of the Ordnance Department in the War Department, and the organization for research and development is almost the same. In the Navy's Bureau of Ordnance, the Division of Research and Development performs practically the same functions as those assigned to the Technical Division of the Army Ordnance Department and is organized along very similar lines.

The Navy has its main ordnance proving ground at Dahlgren, Va., where many of the tests and experiments necessary for the development of naval ordnance are carried out in a manner corresponding to that at the Aberdeen Proving Center for Army ordnance. Likewise, the Bureau of Ordnance has throughout the country a number of smaller laboratories and proving grounds especially established for the prosecution of specific projects. Those who do not appreciate the different requirements of the two services may well ask why these various facilities should not be combined and why single facilities could not perform this work for both services with considerable gain in efficiency and saving in cost. The major reason lies in the very real differences between the requirements of the two services. With the Army, mobility is a prime requirement, whereas with the Navy, weight and space limitations on board ship are prime considerations. Mud and dirt are Army problems; salt spray and corrosion affect the Navy designs.

A second but almost equally fundamental difference is in the character of the objectives normally assigned the two services; their weapons must be designed accordingly. A third but lesser objection is that of the magnitude of the task involved. As it is, the magnitude of the research problems affecting either service is of such order that a combined organization would be so large as to be unwieldy. This is one of the many cases where decentralization is essential, since speed must be a vital factor in wartime research problems.

In ordnance research, duplication of effort is avoided and conservation of resources is obtained to a very satisfactory degree, in so far as the Navy is concerned, and, it is hoped, equally so for the Army, through the very close contacts maintained between the Technical Division of the Army Ordnance Department and the Division of Research and Development of the Navy Bureau of Ordnance. Representatives of both services regularly attend the conferences and meetings held by the other. It is doubtful if a day passes that direct personal contact is not established by some members of the respective research organizations. By mutual agreement between the two services, the Army Ordnance Department assumes the responsibility for research in regard to certain weapons, whereas the Navy Bureau of Ordnance assumes corresponding responsibility for other items. Because of the complexity of the problems involved, no specific rules for this division of responsibility can be laid down. The general rule is that the service having primary interest handles the development. So far as I know, there has been no single instance to date where satisfactory arrangements have not been worked out by the two services.

A SIMPLE case in point is that of aircraft bombs, where the development of armor-piercing bombs, which because of their nature are primarily naval weapons, is done by the Navy Bureau of Ordnance; whereas the development of fragmentation, antipersonnel, incendiary, and other bombs more generally used against land objectives is being handled by the Army Ordnance Department. The Navy receives from the Army a large proportion of its aircraft bombs. On the other hand, the Navy furnishes to the Army many of the bombsights which have contributed so much to the outstanding results obtained by the Army Air Forces.

A great deal has been done toward standardization of weapons used by the two services. The designation "AN," indicating that the particular equipment has been adopted as standard by both the Army and the Navy, is appearing more and more on matériel issued to our armed forces.

In wartime, ordnance research has at its disposal the resources of the country. Unfortunately, but understandably, this has not hitherto been the case in times of peace. This great country of ours is not a militaristic nation, and relatively few of the weapons of modern warfare have sufficient commercial application to insure continued interest in their development. On the other hand, the aircraft, the automobile, and many other necessities of twentieth-century warfare not only have a strong popular appeal but a very real commercial future which insures the continued interest that will guarantee and provide for adequate research.

In this war, as in World War I, our enemies were heavily engaged when hostilities were forced upon us. We may not be so fortunate again. Under the very best conditions it usually takes a year or eighteen months—or even longer—after the inception of a new weapon before that weapon can be designed, procured, tested, and issued. It is imperative, therefore, that ordnance research never be allowed to lag.

Captain Moses is director of the Research and Development Division, Bureau of Ordnance, U. S. Navy. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Small Arms in Action

Our Weapons Meet the Test of Battle against the Japanese

Lieut. Col. V. H. Krulak, U. S. M. C.

THE United States Marines represent the other end of the war-matériel horn—you manufacturers design and fabricate the materials, and we use them. The U. S. Marine Corps parachute troops, with which I have recently been associated, are predominantly equipped with small arms, and you might be interested in hearing a little first-hand information concerning their actual performance at the battle front under combat conditions.

Some weeks ago, a task force under my command was rather busily engaged in destroying Japanese soldiers and marines with these weapons, and I am very happy to be able to give you a front-line account of how a few of them work. Some of these weapons may be ones with which you are intimately acquainted because of manufacture or design, and others may be strangers to you. None of them are strangers to the Japanese!

One of the most outstanding weapons with which the Marines are equipped is the Garand rifle. It is magnificent. To say anything further about it would merely gild the lily. We also had the Springfield rifle, the weapon with which we entered the war. We used it to mount the launchers for the antitank grenade. It is still a wonderful rifle, and I am sure it is better than anything our enemies can put in the field.

U. S. Marine Corps

MARINE PARATROOPER USING THE REISING SUBMACHINE GUN

The antitank grenade—one of our favorite weapons—is a development of this war. It was designed for the destruction of enemy tanks by infantry soldiers. My men put it to uses which I am sure the designers did not contemplate when they had it on the drafting board. They visited its destruction upon the Japanese in a number of interesting ways. It is useful against personnel and against many types of matériel other than tanks. It is supposed to detonate only against the sides of tanks and similar hard objects, but we learned by experience that it will go off even if it hits a Japanese!

The carbine also is a development, militarily, of this war. My organization of parachutists were armed with a folding-stock carbine which makes a very short and compact weapon. It is a high-velocity weapon with sufficient driving power to push a bullet through the heavy jungle foliage, the character of which I shall not undertake to describe beyond saying that it beggars description. The carbine is accurate and light in weight, and, most of all, its ammunition is so light that an individual can carry seventy-five rounds on his person and not realize he has it there. The men have great confidence in the carbine, and it works extremely well.

The bazooka, too, is a development of this war and an interesting one about which there has been little reservation in discussion. Simple as it is, it is a very valuable affair, I dare say, in the destruction of tanks. I have never seen a Japanese tank, so I cannot speak from experience, but we found it most effective in destroying Japanese landing barges. We also found it effective in many other ways, with uses similar to those of the antitank grenade. This rather simple and inexpensive development is making itself vigorously felt against our enemy in the Pacific.

The light machine gun, termed M1919A4, we look upon with the greatest affection because it fires and fires and never fails. It is a truly American development and one which has no peer in all the world, I am sure.

The 60-mm. mortar, another American development, is also a splendid weapon. Contrary to the basic principles of employment, we were forced on one occasion to shoot these mortars almost entirely submerged in water up to, I should say, within three or four inches of the muzzle. The sights were submerged in salt water from time to time, and their employment was quite unconventional, but they performed in combat—and that is a characteristic of all our weapons.

The Browning automatic rifle, an outgrowth of World War I, is an extremely powerful, effective, and dependable weapon. My organization replaced it with a later and extremely efficient weapon—the Johnson light machine gun.

The weapons with which you provide us are effective, and, as one who has met the Jap on one slight offshoot of the long and bitter road to Tokyo, I am very happy to say that these materials which you are producing are sound, they are good, they are adequate—and we are grateful.

Colonel Krulak, Headquarters, U. S. Marine Corps, is a veteran of the campaign against the Japanese in the Southwest Pacific. He received the Navy Cross for outstanding heroism displayed against the enemy as commanding officer of the 2nd Battalion, 1st Marine Parachute Regiment, during operations on Choiseul, British Solomon Islands. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Ordnance in Jungle Warfare

An Analysis of Our Fighting Equipment in the Southwest Pacific

Maj. Gen. Albert W. Waldron

THE remarks I shall make are from the viewpoint of the user of the matériel produced by Ordnance and industry. I was in New Guinea about a year ago and saw some of that matériel in action against the Japs. I also saw some of their matériel in action against us. Such experiences drive home the great advantage superiority in equipment provides when you come face to face with a desperate and determined enemy.

Any one serving with good soldiers using good weapons cannot help but be impressed by the affection with which they regard their weapons. Moreover, soldiers are extremely proud of special records established by their particular weapons. It may be a matter of accuracy or dependability or speed. The sniper makes a difficult shot at long range; the grenadier wipes out machine gun nests with grenades that never fail to go off; the machine gunner keeps his gun in action until it practically melts—and without a stoppage; an artillery battery destroys a tank, blows up a bunker, tears an infantry group apart with air bursts, fires thousands of rounds of ammunition without a gun going to the shop for repairs. Such weapons the men love, and they will spend much time in their care and adjustment. On the other hand, if their weapons are not good, if they fail to function properly, if they are inferior, the soldiers lose faith in them quickly, and the results may be disastrous.

By preference, I am an artilleryman and have spent practically all my commissioned service with the Field Artillery. In the New Guinea action I was division artillery officer and hence had the opportunity to see in combat the artillery we had there at the time. What I say will be primarily from the viewpoint of an artilleryman.

The jungle imposes exceedingly difficult operating conditions. Without roads and with visibility limited to only a few yards due to density of the foliage, movement of men and equipment was a great problem. Movements by sea, as well as by land, were sometimes also very hazardous. For example, on one occasion four small boats were moving along the northeast coast of New Guinea. One of them, a Jap landing barge captured by the Australians, was carrying artillery weapons and battery equipment. Seven Jap Zeros flew over unexpectedly and succeeded in setting all four boats on fire. The Japanese barge, of which I was in charge, was soon in flames and too hot to stay on. Three men were killed. The rest of us stripped and swam a mile and a quarter to shore.

The heat and humidity in the jungle are intense. Conditions are ideal for rust, corrosion, and deterioration, and on both men and matériel the effects are terrific. Equipment must be good to function and endure under these conditions. Much of the fighting was in hand-to-hand combat or at ranges of only a few yards. I saw only a few live Japs, but many dead ones.

The Japs had prepared long and thoroughly for jungle warfare. Their jungle weapons are light and especially adapted to this type of fighting. One of these, a caliber .25 rifle, put me out of action.

In the early stages of the campaign, much of our newer equipment, such as carbines, landing barges, special artillery for air transport and personal jungle equipment was not available to us. One of the items of our equipment which stood out from the start was the caliber .30 Garand rifle. It is an excellent weapon, greatly admired by the soldiers.

AT first it was thought that our division artillery and heavier auxiliary weapons were too heavy to be considered for jungle combat. This continued to be true when difficult mountains without roads and deep swamps without causeways had to be crossed. However, when organized positions were finally encountered, including well-camouflaged bunkers connected by trenches, it became evident that artillery weapons would either have to be employed or the loss to our infantry would be very high. Eventually, landing fields or beaches close to the operation were opened up, and it was found that even the 105-mm. howitzer could be transported by plane or ordinary small island boats. Incidentally, the 105-mm. howitzer is a superb weapon, durable, accurate, and with great firepower. With the very efficient high-explosive time shell it has a devastating effect on personnel. It was better by far than anything the Japs had to bring against us.

Another splendid piece of artillery is the 155-mm. gun. It was a good weapon in World War I, but the new 155 is much better and has greatly improved firepower, range, and accuracy. It is doing yeoman service on many battlefields. Other outstanding Field Artillery weapons with great capacity are the 155-mm. howitzer, the 8-inch gun, and the powerful 240-mm. howitzer.

From experience with field artillery, both in peace and in war, I can say with assurance that Ordnance and industry have provided us with weapons that are equal or superior to those in the hands of our enemies. Furthermore, when good equipment is given to our men and they are taught how to use it, we can rest assured they will put up a fight of which both they and we may be proud.

EDITOR'S NOTE.—Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, in an address before the Milwaukee Post of the Army Ordnance Association, said:

"One of the most impressive and highly revered pieces of heavy artillery now in the hands of our troops is the gun that is affectionately known as "Long Tom." It is the 155-mm. gun on high-speed carriage. It is one of the most remarkable pieces of fighting equipment the world over. In spite of its low over-all weight of about 30,000 pounds, it has a range of more than 25,000 yards. It fires one round a minute, and it has a muzzle velocity of 2,800 foot-seconds. Its carriage is the split-trail type. It can be towed by a prime mover at the speed of a truck."

General Waldron is a veteran of the campaign in the Southwest Pacific. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Gliders Away!

ONE of the newest and most spectacular of our weapons of modern warfare is the troop-carrying glider. Snatched fully loaded from the ground by huge towplanes, these lightweight ships are pulled to a high altitude, release their tow ropes, and then glide silently to their objectives many miles away where they can come to earth in small open spaces or crash-land with relative safety on rough terrain. Once aground, heavily armed troops pour from them, and their huge jaw-like bow doors open to disgorge jeeps, light artillery, grading equipment, and supplies. An airborne force can thus be landed behind enemy lines to seize airfields and other vital installations or to set up a flanking movement. The gliders and towplanes are flown by pilots of the Troop Carrier Command and carry the troops and equipment of the Airborne Command.

The Army's glider program was initiated in 1941, but large-scale training of pilots did not begin until a year later when the first CG-4A's were produced. The CG-4A is our standard operational glider which can carry 15 fully equipped troops, a jeep and 6 troops, a 75-mm. pack howitzer and crew, or similar loads. It has a wingspan of about 84 feet, and loading and unloading are done through the nose which is hinged to open as shown in the illustration above.

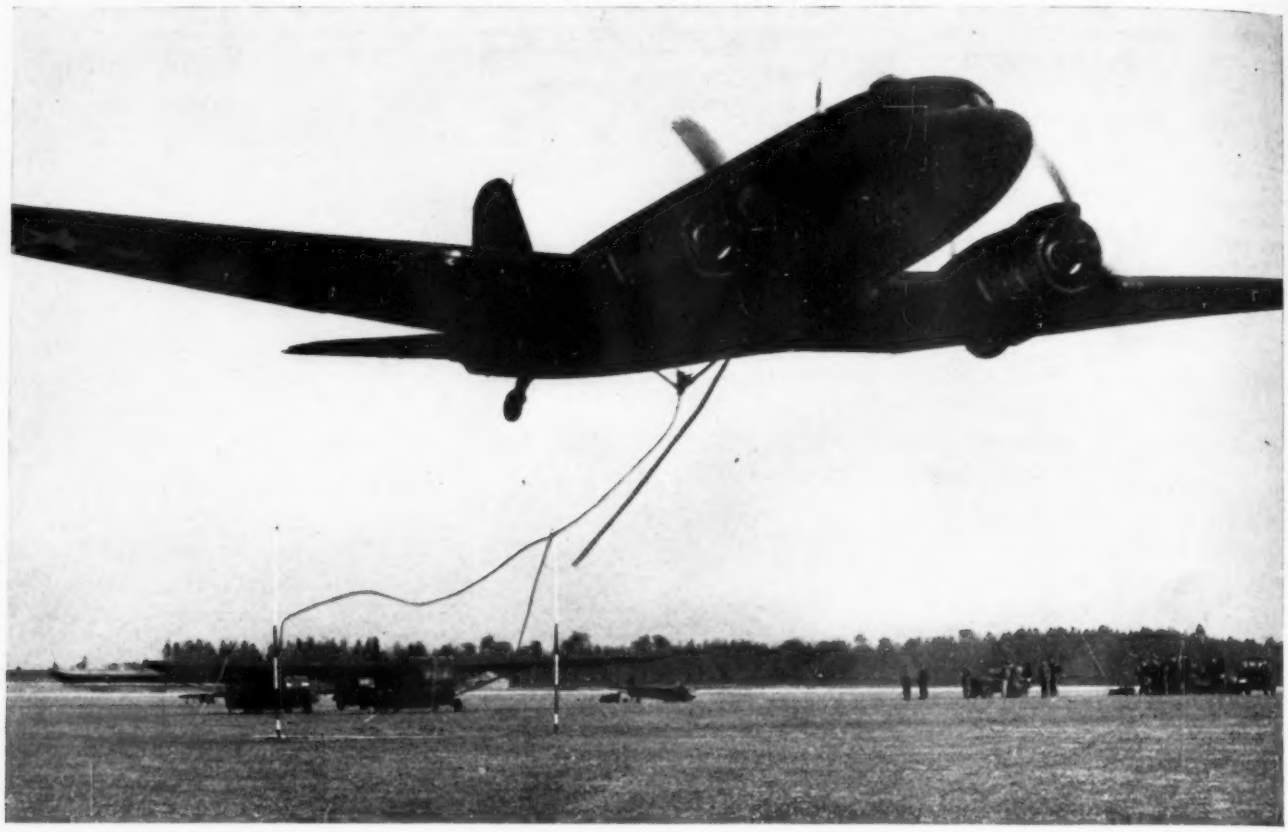
The CG-13A is a larger version of the CG-4A with the same wingspread but a larger fuselage which enables it to carry more than 30 troops or an equivalent load in equipment. A similar glider is the British Horsa which carries about 25 troops. It has jettisonable tricycle landing gear and large flaps which enable it to descend at an angle of 45 degrees.

A most important development in glider technique is the pickup unit installed in the powerful towplanes which enables them to pick up stationary fully loaded gliders from small fields without landing. This technique greatly increases the flexibility of glider operations, for it enables such equipment as radio sets, weather stations, group aid stations, aircraft and ordnance repair shops, field kitchens, and similar equipment to be picked up "on the fly," landed in an otherwise inaccessible spot, and then retrieved when the mission has been accomplished. Gliders also may be equipped with quickly installed litters and used to evacuate wounded from beachheads and other places where planes cannot land.

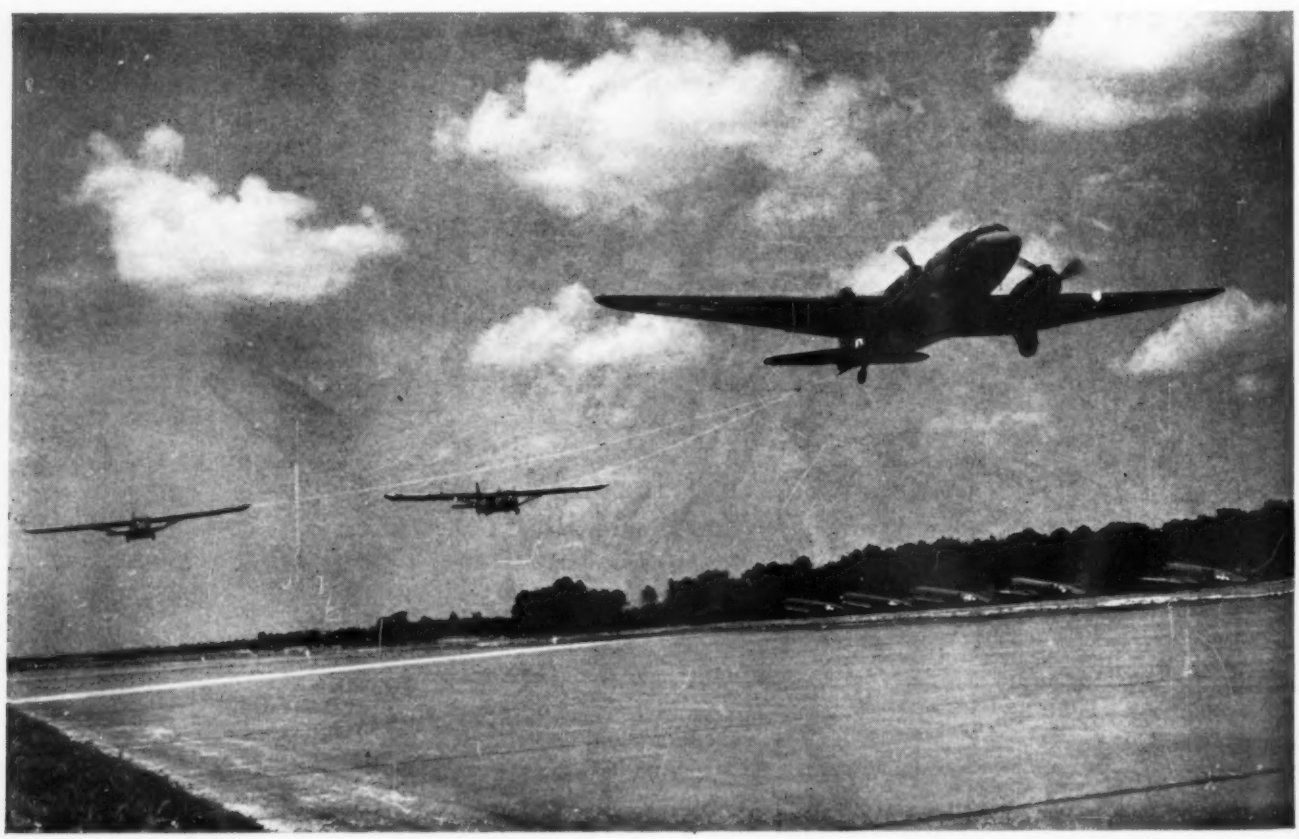
In picking up a glider, the towplane flies over its position trailing a nylon cable from a large reel inside the plane. The glider's cable is stretched out ahead of it on the ground and the end is held up between two small uprights. As the towplane's cable passes between these uprights, a locking device hooks the two cables together. The cable then pays out rapidly from the reel in the plane while a brake applies gradual pressure. Thus the load is slowly absorbed and the glider gently rises from the ground until, when the brake finally locks the reel, it is flying at the speed of the towplane. When the glider releases the cable, it is reeled into the towplane.

Once aloft, the glider's wheels may be jettisoned to decrease wind resistance. In landing, spoilers or flaps on top of the wing enable it to descend at a steep angle and with low forward speed so that it can come to rest easily on skids on the underside of the fuselage. While gliders usually can be landed in rough terrain without sustaining major damage, in the event of an all-out attack, such as an invasion, they may be regarded as expendable and crash-landed anywhere that will put men and guns into action as quickly as possible. In this regard, gliders are much more economical than heavier and costlier airplanes. (The accompanying illustrations are from U. S. Army Air Forces photographs.)

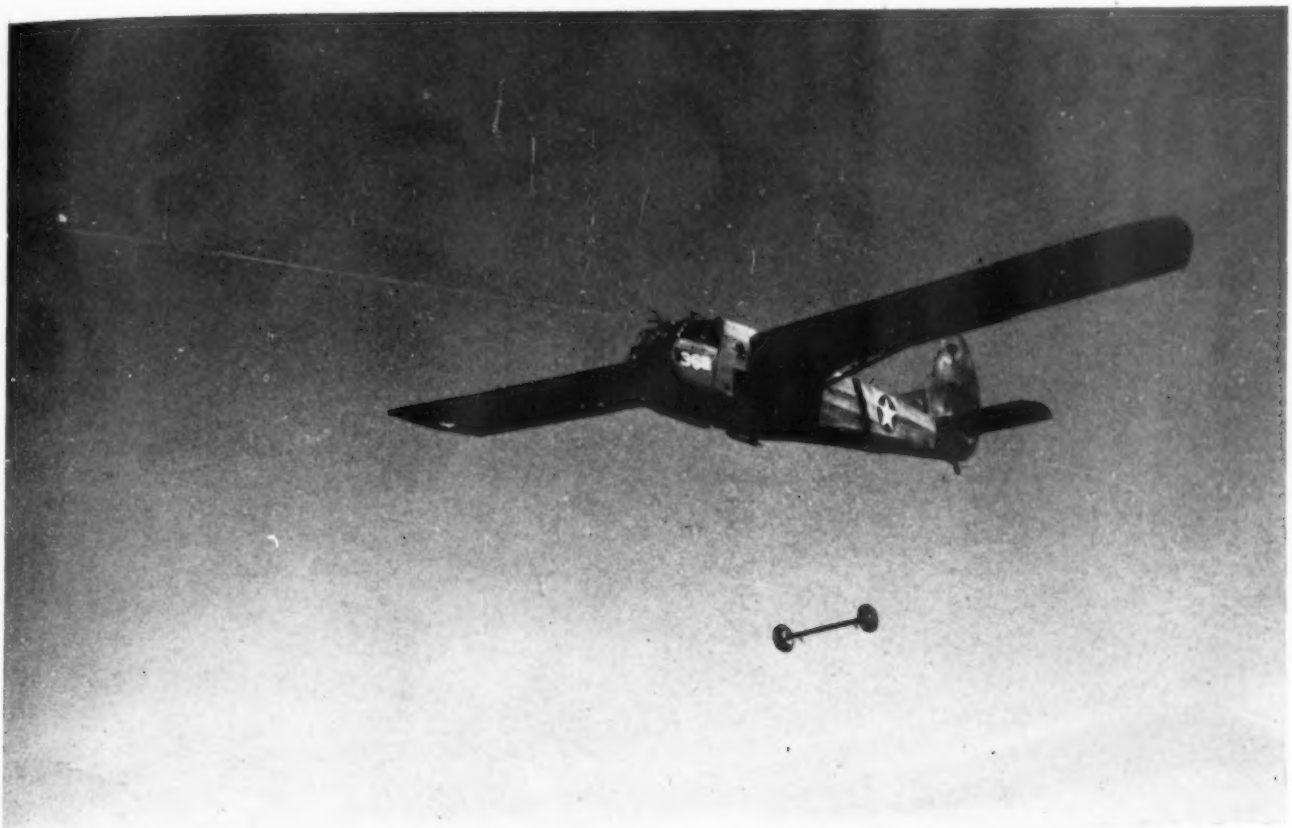
Glider "Pickup and Delivery"



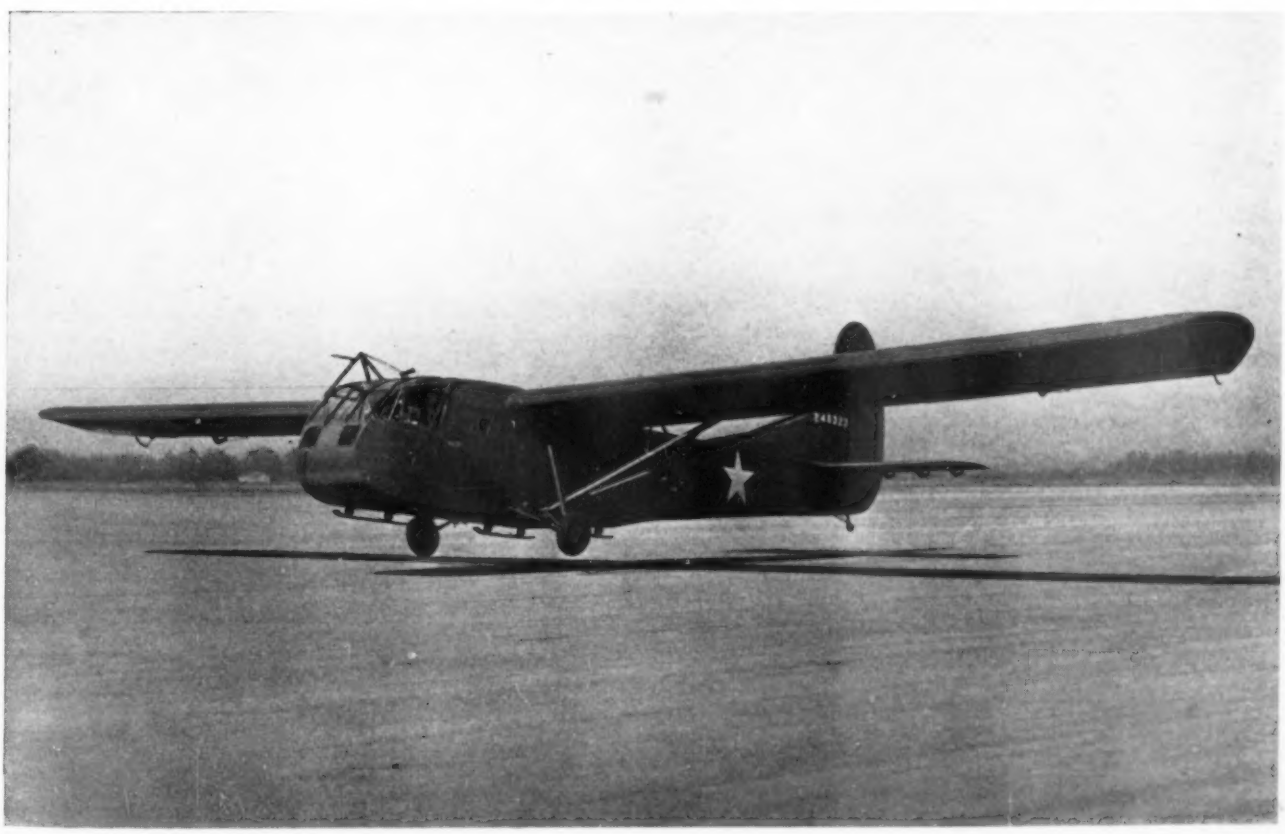
The tow cable from the Douglas C-47 "Skytrain" in the above photograph has just hooked onto the cable of the CG-4A glider in the background which will be towed aloft as a brake is applied to the cable reel in the plane. In the photo below, a C-47 is shown towing two gliders after a regular take-off. One glider flies slightly higher and to the rear of the other.



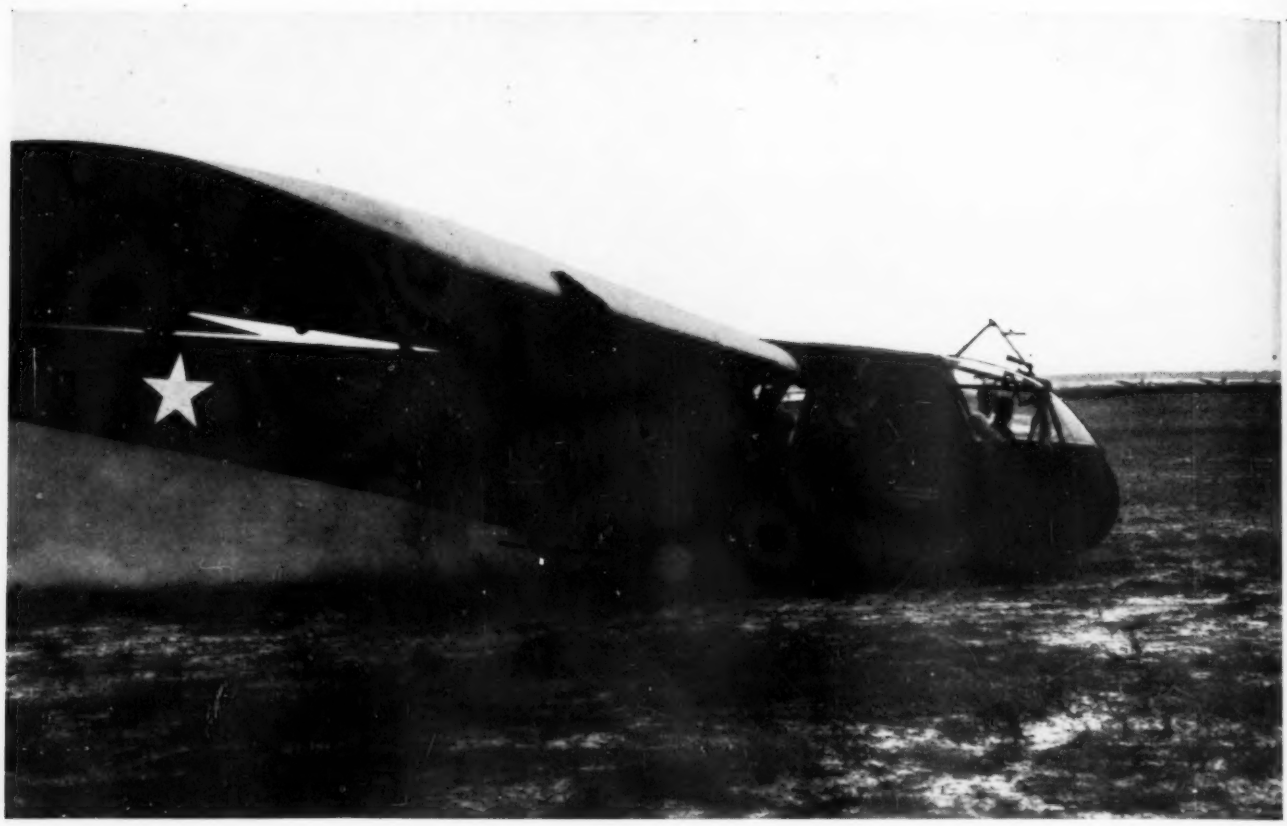
The CG-4A 15-Place Glider



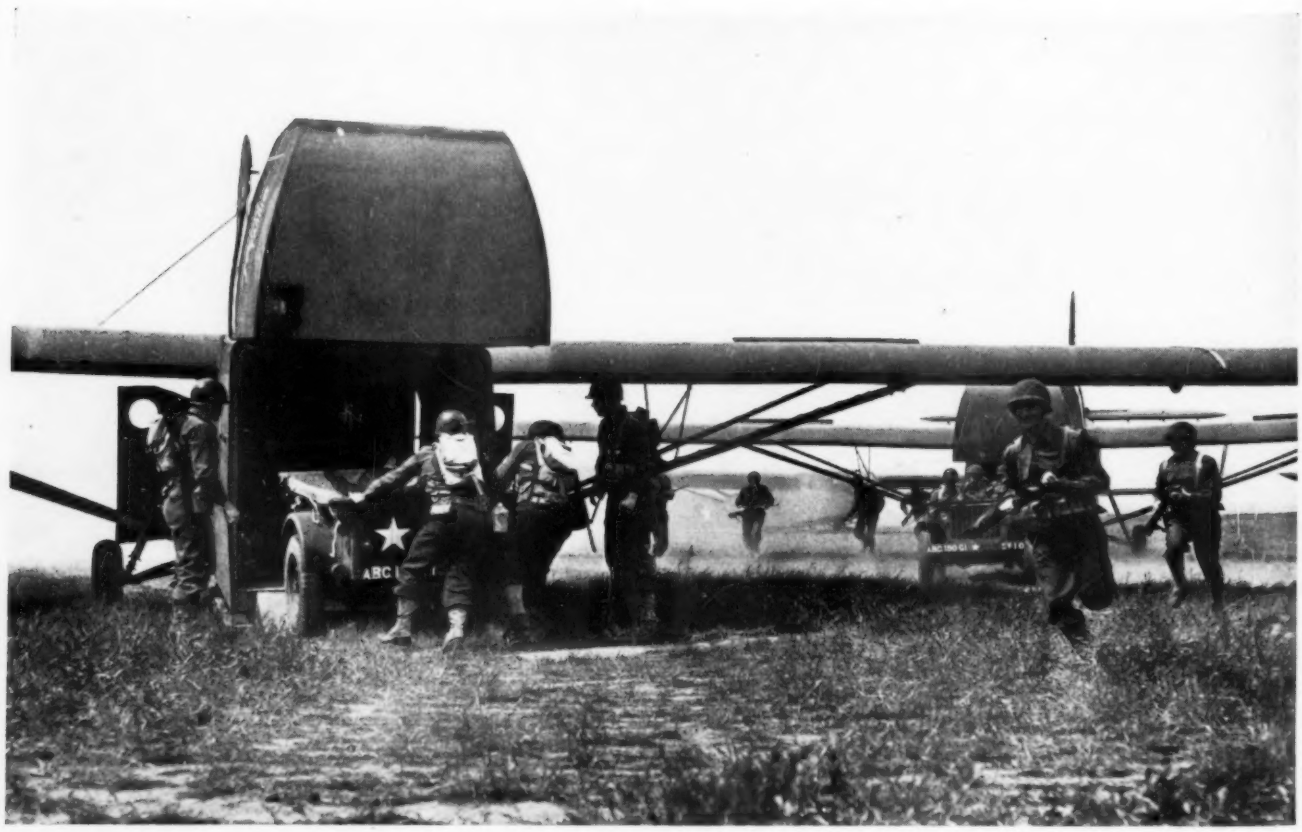
Once aloft, the glider can drop its wheels, as shown above, and come to earth on the skids underneath the fuselage. This permits landings in rough and uneven terrain. These skids are shown clearly on the CG-4A glider illustrated below. This glider weighs about 3,000 pounds, can carry 15 equipped troops, a 75-mm. pack howitzer and crew, or a jeep and 6 troops.



America's Aërial Commandos—

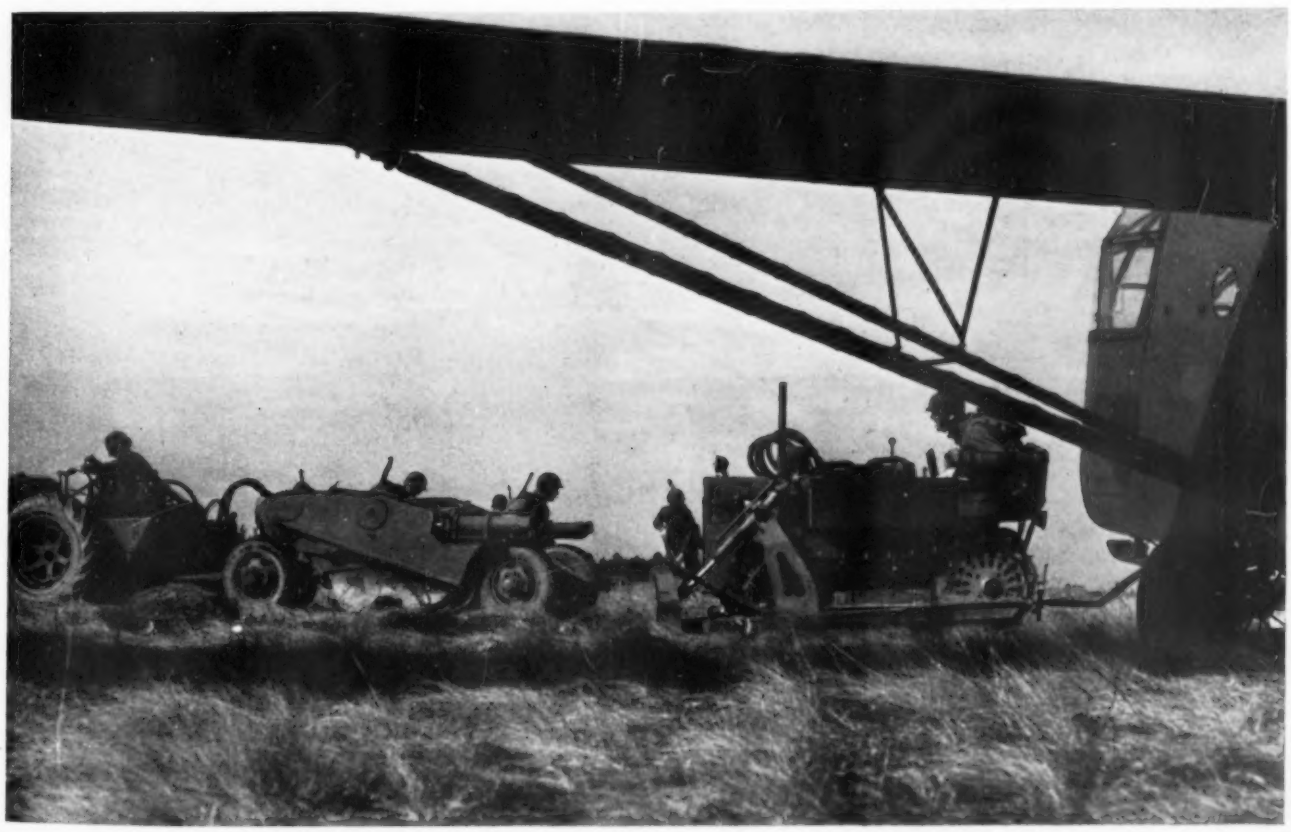


Having released its tow cable, the glider can soar silently to its objective and then come swiftly to earth. By dropping the nose, the skids dig into the ground and the glider comes to a quick stop, as shown above. Troops then pour from the glider and the nose compartment is raised, as shown below, to allow jeeps, guns, and other equipment to roll into action.

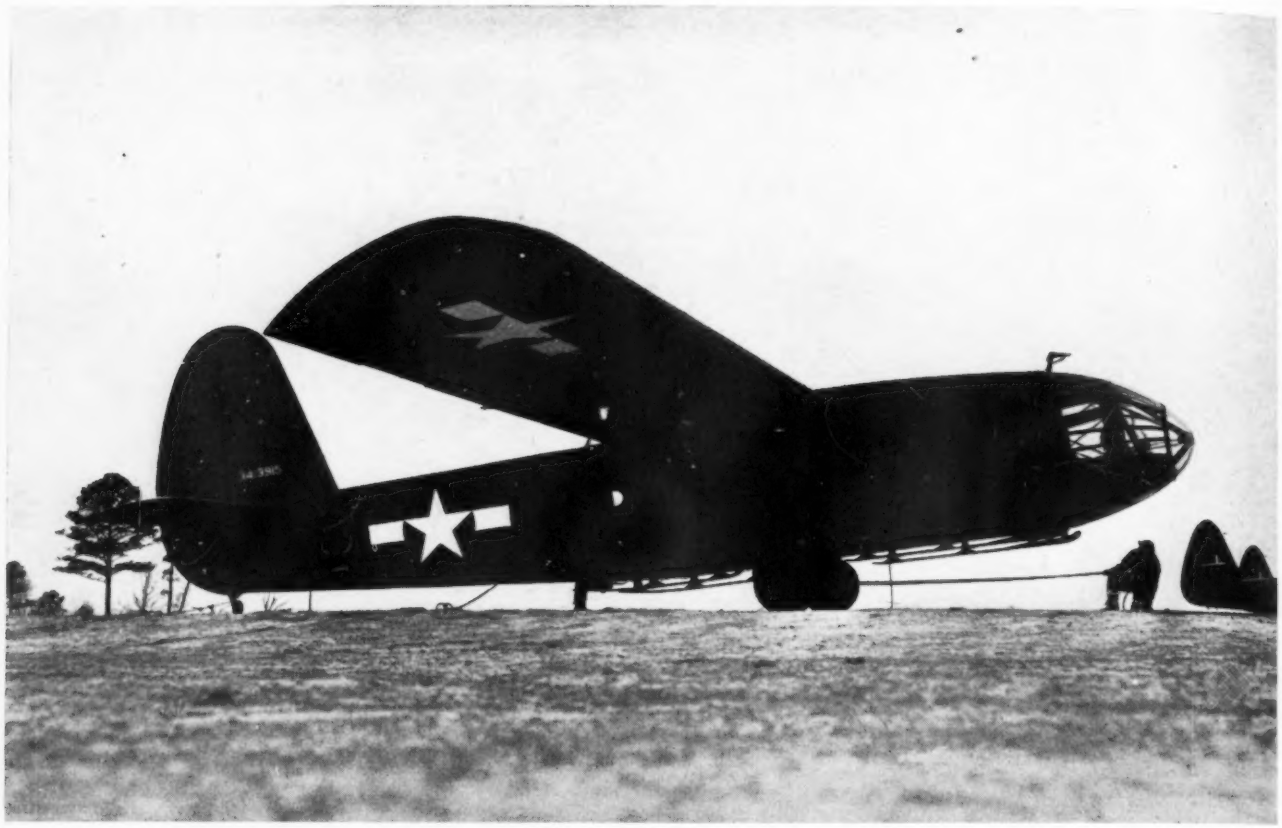


—Establish a Beachhead from the Sky

The attack is now in full swing as more gliders land and more heavily armed troops join those already on the ground. When an enemy airfield is taken, "miniature" grading equipment, like that shown below, is brought in by glider to fill up shell and bomb craters or extend runways. This equipment has been especially developed for the Airborne Command.

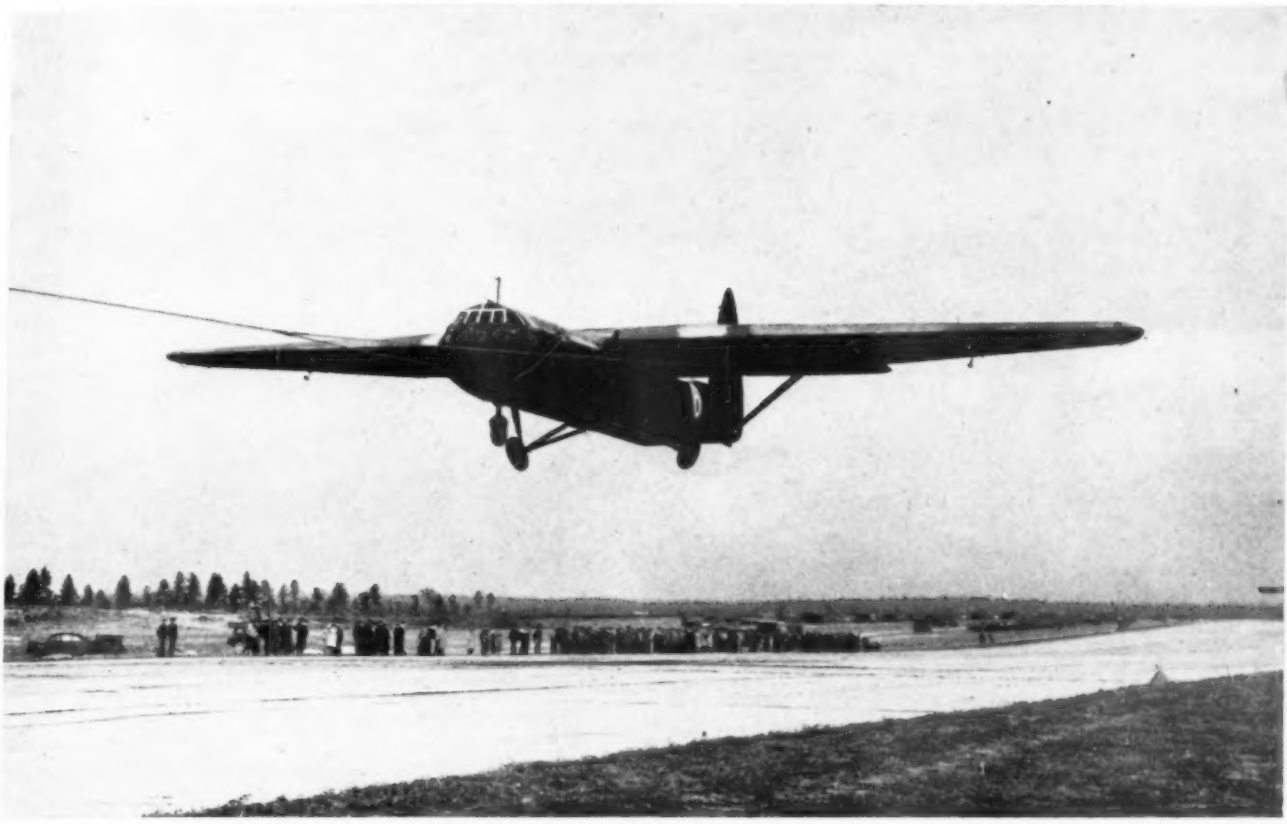


The CG-13 Glider Can Carry 30 Troops

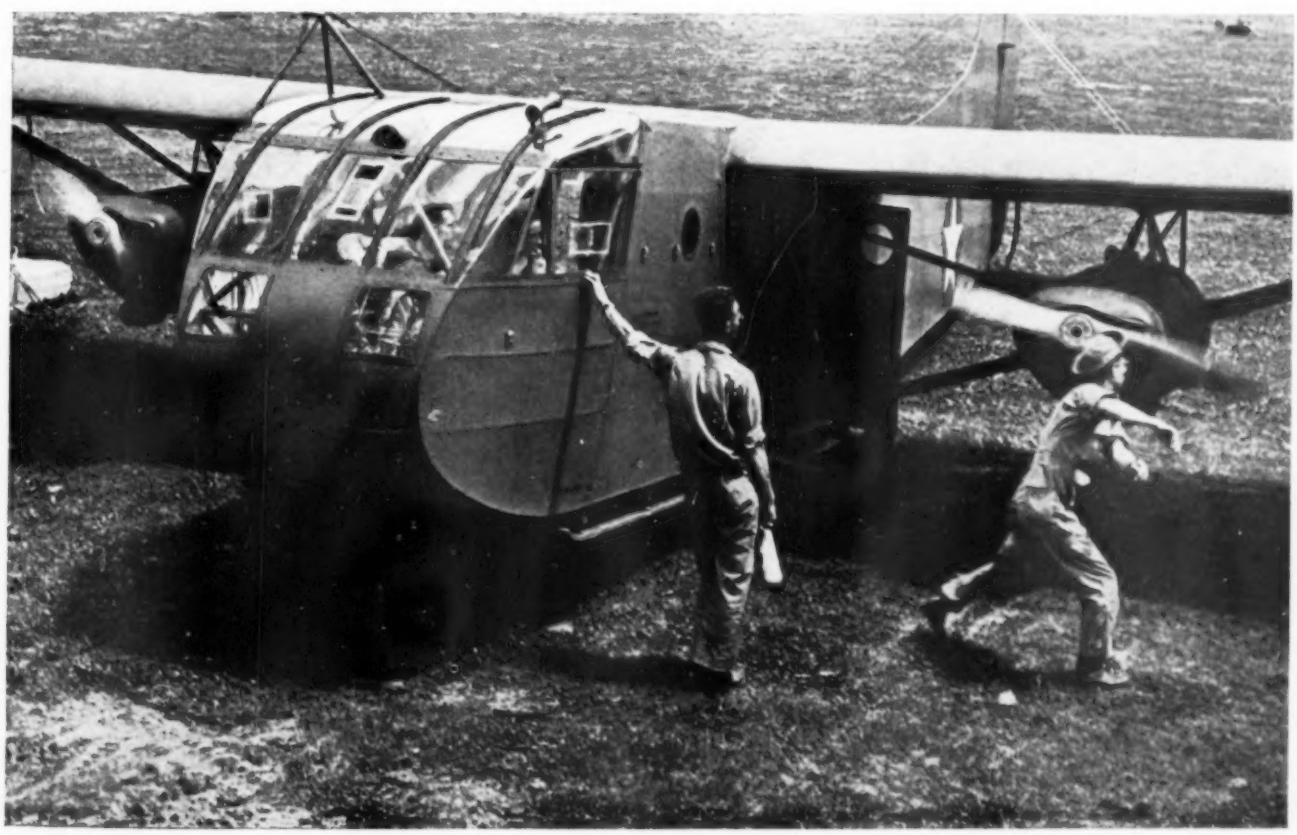


A newer type of glider is the CG-13, shown on this page. It has the same wingspread as the CG-4A but has a wider fuselage enabling it to carry 30 troops or a similar load in equipment. While a glider has no armament, the rifles and submachine guns of the troops being carried may be fired through the portholes which run along each side of the fuselage.

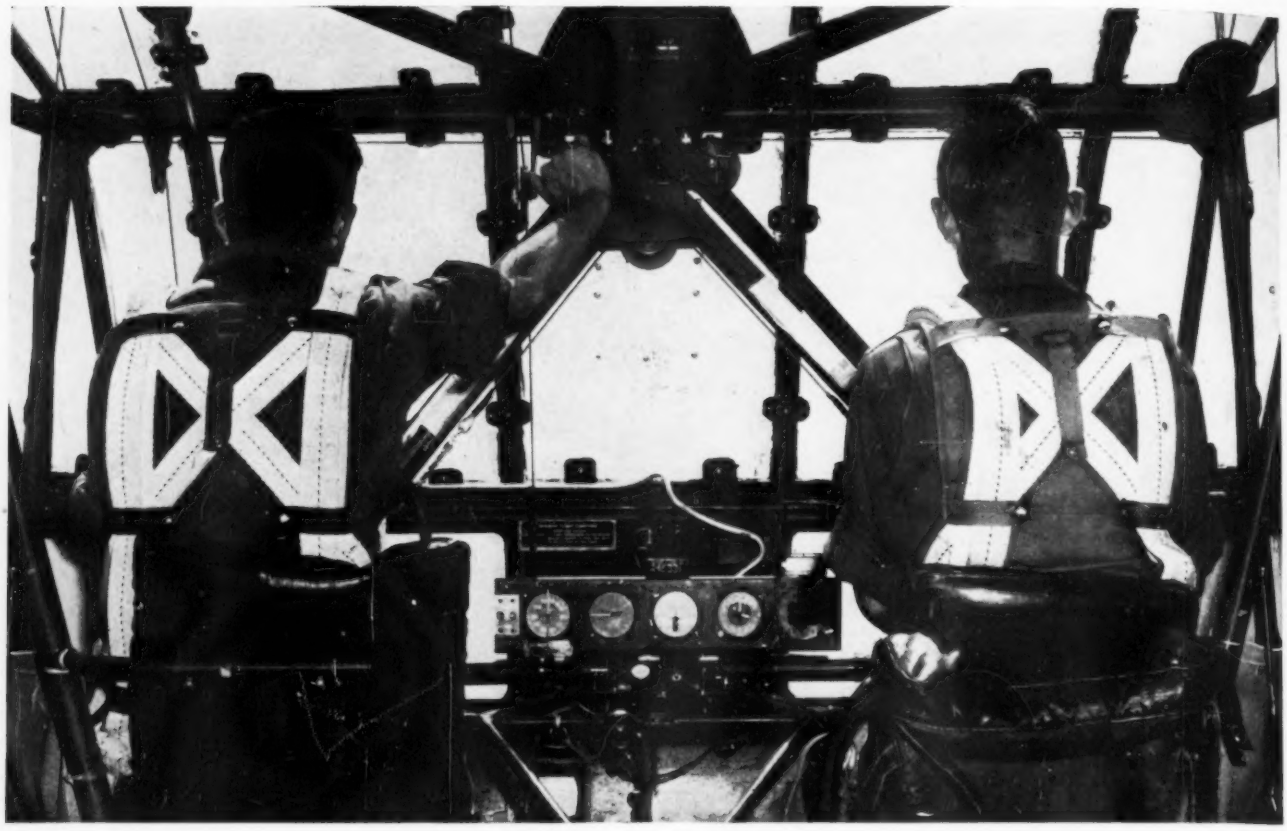
British and American Gliders



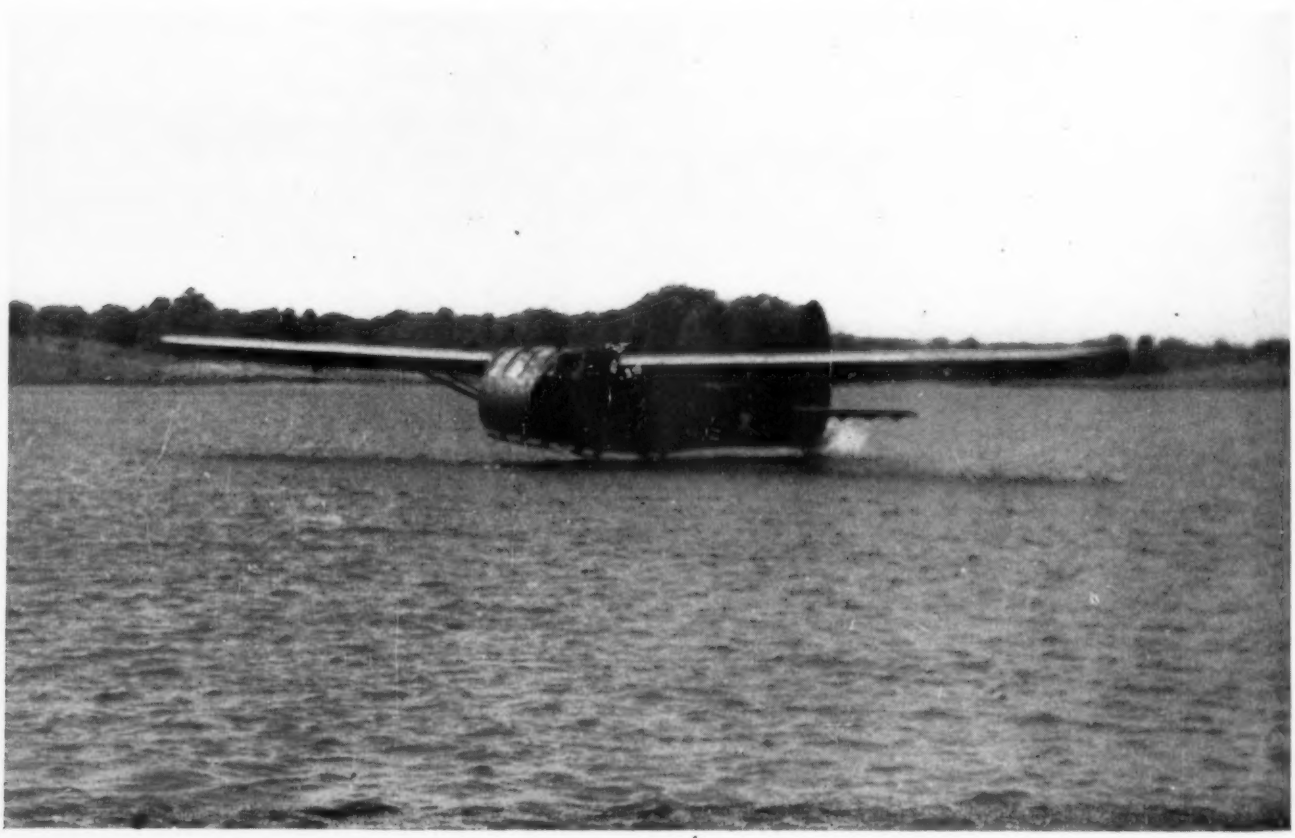
The standard British operational glider, the Horsa, is shown above being towed aloft from a runway. It has jettisonable tricycle landing gear and large wing flaps which enable it to descend at an angle of 45 degrees. It can carry 25 troops. Below is a CG-4A glider equipped with two light engines which convert it into an economical, lightweight transport plane.



Gliders Can Also Alight on Water



Gliders also can alight safely on water when necessary. In the illustration above, showing the pilot's compartment and control panel of a CG-4A glider, the pilot is about to release the cable connecting the glider to the towplane. Below, with main wheels jettisoned, the glider is about to make a "belly landing" on the water. Note that the tail wheel has just touched.



Wartime Research

The Functions of the National Defense Research Committee

Frank B. Jewett

IN amount of money spent on strictly research and development work and in the diversity of fields and problems covered, the National Defense Research Committee is probably the largest organization of its kind in the world. Except for three or four specialized laboratories, such as the radiation laboratory, the two subsurface warfare or antisubmarine laboratories, and one or two other smaller specialized laboratories, it has itself created no new research facilities. Even these specialized laboratories are operated under contract by educational institutions. All other work is done under no-profit no-loss contracts with educational, foundation, and industrial laboratories under supervision of divisions of N.D.R.C. The latter is thus relieved of the necessity of maintaining a vast administrative organization.

The National Defense Research Committee is the World War II edition of the original World War I National Research Council. It is far larger and more efficient than its progenitor, which was necessarily constructed hastily in a situation in which neither military nor civilian science and technology had had any experience in organizing for modern warfare.

N.D.R.C. is by far the larger of the two divisions of the Office of Scientific Research and Development, of which Dr. Vannevar Bush is director. It was established originally by order of the Council of National Defense as a separate agency in the pre-Pearl Harbor preparedness days as a means of mobilizing effectively all the Nation's civilian science for war. The Committee was then, and is now, primarily civilian, being composed of five civilians, the Commissioner of Patents, and one representative each from the War and Navy Departments.

While all its work is done in closest coöperation with the services and while necessarily most of the problems arise directly out of service needs, the Committee has independent funds and full authority to carry on work for which no immediate military need is apparent. Such work, which naturally formed a larger part of the total in the earlier period than at present, is mainly concerned with new applications of science which require development before their military possibilities can be appraised by the services.

Obviously, in the final stages of any development, the embodiment of the work must conform to military requirements, either present or modified. I mention "modified" advisedly because as new tools are developed, new methods for their effective use must be devised. During the last year there has been a rapidly increasing volume of work in N.D.R.C. of aiding the military in developing new methods of warfare and in the selection and training of specialized personnel.

While N.D.R.C. started with a simple organization of four divisions headed by the four civilian members of the Committee, not counting the chairman, the magnitude and diversity of the work grew so enormously that about a year ago we reorganized to relieve the Committee members of executive responsibility, although each member retained general reviewing supervision over about a quarter of the work. The chairman's office, a full-time executive officer, a full-time secretary, and their staffs handle the routine operating affairs of the Committee.

AS at present organized, there are nineteen divisions covering major fields and three special-service panels—engineering, applied mathematics, and psychology—which give aid to all the divisons. There is also a special Vacuum Tube Development Committee which gives aid to any division or on any problem which requires special tube assistance.

Although neither time nor the confidential character of most of the work permits description of the projects in detail, the following summary of the distribution of the work and its general character may be of interest:

Ballistic Research Division.—Deals with gun erosion, interior ballistics, projectiles, and shell stresses.

Structural Defense and Offense Division.—Deals with impact effect of shells and bombs, including blast measurements and earth shock.

Special Projectiles Division.—Deals with various aspects of jet propulsion.

Ordnance Accessories Division.—Practically the entire program deals with various new types of fuzes, most of which are covered by four Ordnance Department directives.

Subsurface Warfare Division.—One Ordnance Department directive covers the use of a high-speed water tunnel to determine hydrodynamic characteristics of projectile forms.

Fire Control Division.—It has developed the M9 electrical director and carried on related optical problems and those associated with training of personnel.

Explosives Division.—Seventeen Ordnance Department directives cover extensive research on new explosives, including study of shock waves, etc.

Transportation Development Division.—Six Ordnance Department directives cover a number of diverse projects, as follows: medium tank cold-starting problem; centrifugal scourer; a study of snow data; automatic screw thread gages; pneumatic tire substitute; gun mounts; ¼-ton amphibian and 2½-ton truck.

Electronics Division.—Three Ordnance directives cover work on range finders and electronic devices.

Optics and Camouflage Division.—Deals with optical devices for use on Ordnance equipment.

Physics Division.—The twelve Ordnance Department directives deal primarily with mines and, in particular, methods of locating mines and unexploded bombs. In addition there are the projects on the magnetic compass and degaussing, and also a project on the effects of the high ambient noise levels on man, such as battlefield noises.

Applied Mathematics Panel.—One Ordnance Department directive covers a statistical study of "clearance of land mine fields," associated with the project in the Physics Division.

Dr. Jewett is president of the National Academy of Sciences and a member of the National Defense Research Committee. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Laboratories at War

Achievements of Massachusetts Institute of Technology

Dr. Gordon S. Brown

THE Technical Division of the Ordnance Department and certain facilities of the Massachusetts Institute of Technology have formed a partnership for the development of some of the combat equipment for this war. It can be truthfully said that this partnership was promulgated early in 1941. At that time, the country at large was not as strongly behind the armament program as it was after Pearl Harbor. Outwardly, M.I.T. was still primarily a college, with its usual assemblage of youth and age, pledged to teaching and research. But to those of us who had affiliation with the Division of Industrial Coöperation at M.I.T., there was evidence of a startling amount of activity in small corners of laboratories or basement cubbyholes. There were also new faces crossing the threshold from time to time; namely, the representatives of the development and technical branches of the armed services, research directors from industry, and various representatives from the Office of Scientific Research and Development.

The Department of Electrical Engineering at M.I.T. has contributed extensively to the professional aspects of our work. The Division of Industrial Coöperation, although a lusty member of the Institute family prior to 1940, has grown to be the ranking department from the point of view of personnel during the past few years. It is this department which acts as contracting officer with the Army, the Navy, the O.S.R.D., and with private industry for the utilization of the institute's facilities on behalf of the war effort. The specific facility with which I am intimately connected, namely the Servomechanisms Laboratory, is administered by the Division of Industrial Coöperation.

By comparison with other organizations, the contribution of M.I.T. may have been small, but I believe it has been effective. Its effectiveness in fields other than study and learning are attributed to the coöperative efforts of representatives of the Ordnance Department and the administration at M.I.T. Dr. Karl T. Compton, our president, gave leadership, and funds were allocated in advance of contracts. N. McL. Sage, director of the Division of Industrial Coöperation, understood the details of the problem ahead and gave his keen personal interest. The officers of the Ordnance Department collaborated with us and helped to form a smooth-running combination. To appreciate fully the job being done, let me mention that during 1942-1943 the Division of Industrial Coöperation handled 162 contracts involving an expenditure of more than $15,000,000. Of these contracts, 49 were with the Army, Navy, or National Advisory Committee for Aëronautics, 53 were with the O.S.R.D., and 60 were with industrial firms on behalf of their war work.

The work of the Servomechanisms Laboratory relates in brief to the problem of automatic control. Servomechanisms are remote-control systems which allow a person to perform motions with great precision at high-power levels from remote stations at low-power levels. This, as you know, has many applications in modern warfare. My first affiliation with the subject grew out of an academic interest in automatic-control devices. In 1939, the Department of Electrical Engineering at M.I.T. offered for the first time a program of graduate study in this field. Out of this educational program, there developed an association with the Sperry Gyroscope Company. We first performed for Sperry a number of fundamental studies in the general field of servomechanisms. We then undertook for the Ordnance Department, jointly with Sperry, the design of specific equipment that eventually was turned over to the Technical Division for field trial. Direct contracts were later made with Ordnance, both at Frankford Arsenal and at Washington. Tangible results of this initial work can be cited in certain components of this Nation's heavy antiaircraft equipment.

By this time, M.I.T., and specifically the Department of Electrical Engineering and the Division of Industrial Cooperation, could clearly see the job that lay head. It appeared to have three rather distinct but closely related parts. The first was the training of technical personnel badly needed in the expanding field of servomechanisms. At no time has the Institute's educational program shown a decrease. The teaching staff is now almost wholly occupied with Army Specialized Training, Navy V12, and programs in special techniques for the training of officers of the Army and Navy. The second part was an intensification of fundamental studies in servomechanisms as pertaining particularly to military equipment. The third was by the direct application of the talent and fundamental knowledge available at an institution like M.I.T. to the development of equipment needed as components of automatic-control equipment already planned and much needed by the using arms. Here there appeared need to apply the rigorous quantitative design principles evolved from the fundamental studies, rather than merely to proceed with instrument "gadgeteering."

Blitz development techniques were adopted by our group in coöperation with the Ordnance groups. In some instances we have been asked to develop components of new weapons. Because of the flexibility maintained in our organizational setup, our efforts often make possible a large decrease in engineering time normally associated with such work.

We have also been asked to develop substitute components for weapons already in use, either to remove weaknesses in the systems or to extend the effectiveness of the weapons. Such developments become rush jobs and we are at the present time helping to smooth out roughness resulting from accelerated production schedules for some of these components. Finally, we have been asked to assist with initiation of research for wholly new and more potent combat equipment. Frequently this is on a short-range basis; occasionally on a long-range basis. To do these things, our usual educational facilities have been supplemented by the addition of groups of scientists, engineers, draftsmen, technicians, toolmakers, machinists, and the necessary clerical force to form a well-rounded engineering organization.

Dr. Brown is director of the Servomechanisms Laboratory at Massachusetts Institute of Technology. This is an address delivered at the Ordnance Engineering Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Military Education

Training the Ordnance Soldier for Maintenance in the Field

Brig. Gen. Harry R. Kutz

THE ultimate purpose of all military training is the assurance of victory. Successful training develops and fosters in the individual and in the unit of which he is a member those qualities necessary for success in battle; namely, morale, discipline, health, strength and endurance, technical and tactical proficiency, initiative, adaptability, leadership, and teamwork. The object of individual training is the development of the skill and knowledge necessary to enable him to play his part effectively in the military team. Unit training is designed to promote the development of teamwork and leadership and the application of doctrine and technique to situations in the combat theaters.

That outstanding statesman, Bernard M. Baruch, has stated that the essential elements in waging modern warfare comprise men, money, machines, munitions, and morale. Modern battlefields are maelstroms of men and machines—a multiplicity of machines of a complexity and variety hitherto undreamed of in warfare. Airplanes, tanks, self-propelled and antiaircraft artillery, combat and transport vehicles, together with their weapons and fire-control instruments, all are but mobile gun platforms—machines designed to provide maximum firepower to kill enemy soldiers.

Our distinguished Chief of Ordnance, Maj. Gen. L. H. Campbell, Jr., has consistently assured the American people that the weapons and fighting machines with which our soldiers are equipped are at least the equal of and in many instances superior to those of any enemy power. Thank God that this is true and that this phase of the Ordnance mission has been so successfully accomplished! But, to win battles, military machines and weapons must at all times operate at maximum efficiency. Being machines, they are susceptible to wear and tear, malfunctioning, and unserviceability from normal use, and are vulnerable in varying degrees to enemy action.

The combat soldier is carefully trained in the operation and tactical use of his weapons but has neither the tools, the time, nor the specialized skill needed to repair them when damaged or when in need of major adjustment or overhaul. Hence there have very wisely been provided Ordnance units, composed of technically trained Ordnance soldiers, especially skilled in maintaining the fighting man's weapons and transport and in the supply of combat essentials such as spare parts, tools and accessories, cleaning and preserving materials, together with ammunition of all types. As chief of the Military Training Division of the Ordnance Department, all my efforts have been devoted to the training of thousands of Ordnance officers and enlisted men, first to be soldiers—for that is fundamental—and then to become highly skilled specialists and expert technicians, fully qualified to perform the vital mission of supply and maintenance of all ordnance matériel in the various theaters of operations.

The four distinguished speakers who are to participate in this panel will discuss in more detail various aspects of civilian and Ordnance training, but, in order to understand better the present training situation, it may be well to consider briefly the pattern of Ordnance training prior to mobilization, to touch briefly on some of the major problems involved, and to high-light the over-all picture of the current program.

Prior to this war, the Ordnance Department maintained small schools with a capacity of only several hundred students at Raritan Arsenal, N. J., and at Aberdeen Proving Ground, Md. Students were specially selected, above-average, experienced career soldiers. Time was not an important factor, and instruction was somewhat leisurely, with courses extending over varying periods of from nine months to a year. Little detailed planning was required, as courses covered practically everything there was to be taught about a particular subject. There were few training aids—the weapon or item of equipment itself was usually available. There were few instructors' guides, as the knowledge to be imparted to the students was contained in the minds and experience of a comparatively few veteran instructors. Schedules were quite flexible. We took considerable time to train an Ordnance soldier-technician as a Jack-of-all-trades. In other words, our training in those days proceeded at a pace and with a scope traditionally familiar in the academic field. We covered the subject fully and were not too greatly concerned about the length of time required.

PEARL HARBOR and subsequent rapid mobilization changed all this. From the factory and the farm, from business and the professions, thousands of men, instead of the dozens we had previously trained, poured into our inadequate facilities. It was our job to convert these men into highly skilled Army specialists—experts in tank engines, skilled optical repairmen, ammunition handlers, artillery mechanics, storage and supply experts, or bomb-disposal technicians—to cite only a few. Recruits were chiefly men with no outstanding technical, military, or combat background (except perhaps in the automotive field)—thousands of them—to be transformed into soldier-technicians in an incredibly short space of time.

In our present discussion we shall have little time to dwell upon the purely military phase of our Ordnance training, the transformation of the highly individualistic citizen into the trained and disciplined soldier, his indoctrination as to why we fight, the building up and sustaining of his morale, and the inspiring in him of the will to win, although all these are important—yes, vital—factors in his education and training. Suffice it to say that necessary emphasis has been placed on these factors to insure satisfactory results.

I shall touch briefly upon a few of the major problems and difficulties which it was necessary to overcome. The fantastic increase in the number of trainees and the pitifully inadequate time allotted for their training were only two factors. There were many others. Initially, there was an almost hopelessly top-heavy proportion of students to available instruc-

General Kutz is chief of the Military Training Division, Ordnance Department, U. S. Army. This is an address delivered at the Ordnance Training Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

tors, which therefore involved the selection, development, and training of numerous instructors concurrently with the training of selectees. There was an acute shortage of the actual weapons and other items of equipment needed for instructional purposes. This serious shortage required the development of new and improved training aids of various types as substitutes for the material which could not at first be made available to us.

CONSIDERABLE time was consumed in transferring the technical lore contained in the minds of our few veteran instructors to printed instructors' guides for the use of the new and less capable instructors. Our woefully inadequate training facilities indicated the necessity for vastly increased physical plants, the construction and equipment of which had to proceed apace with training. Over all was the handicap of a general lack of technical and military background, previous experience, and knowledge on the part of these men from the farms and the offices—a lack of prerequisites which previously were thought to be quite necessary in the training of technical experts. We got along as best we could with our existing training capacity, utilizing tents and open-air instruction and many other expedients. We reopened abandoned Civilian Conservation Corps camps to provide necessary buildings and makeshift facilities for carrying on our instructional program. We discarded the time-consuming endeavor of trying to train a Jack-of-all-trades and concentrated, instead, upon turning out highly skilled technicians in specialized fields.

We energetically revamped and revised the subject matter taught so as to eliminate, in so far as practicable, all non-essentials, retaining only the "must-know" material deemed absolutely essential to the training of individual technicians. We changed our method of approach in planning our instructional program. Instead of defining a course of instruction in terms of the subject matter to be taught, we attempted to define it in terms of the specific end results the trainee was expected to achieve and of those measures and procedures necessary to accomplish this.

We needed a specific product rather than a course of study. Hence the development, with the enthusiastic and efficient assistance of our friends in industry and in the educational field, of what might be termed "prefabricated" courses of technical instruction designed to accomplish specific missions. We designed clear, concise, highly concentrated courses, drastically reduced the time allotted to classroom theory covering principles and related information, and increased the emphasis on practical work by devoting approximately eighty-five per cent of the technical training time to such work.

In our own courses of instruction we have borrowed and adapted ideas and methods from many sources in evolving and developing our training programs. We sought assistance widely and welcomed suggestion and constructive criticism. We utilized available capacity in trade and vocational schools and in the training schools of the large automobile manufacturers to bridge the gap between the heavy influx of trainees and the expansion or creation of our military facilities. I cannot stress too strongly the vital rôle played by these schools conducted by industry during that critical period. It was just another instance of the fine spirit of coöperation between industry and the Ordnance Department, and the results achieved by the Industry-Ordnance team were vital to the success of our training effort.

I here wish to acknowledge a debt of gratitude and to pay just tribute to those fine organizations and men in industry and in the educational field throughout the entire country who so promptly, generously, and unselfishly gave of their time and effort to help solve our problems and assist in the prosecution of the training program. We are deeply appreciative of the fine contribution they have made and join with them in a feeling of justifiable pride in an outstanding achievement.

As new construction provided increased military facilities, it became possible to concentrate our Ordnance training in fewer installations where related courses of instruction could be grouped and where more efficient and economical utilization of equipment and operating personnel could be achieved.

We have placed particular emphasis upon unit training, which may be considered the ultimate goal toward which all prior military and technical training of the individual is pointed. We endeavor to give to our units in the Ordnance unit-training centers, specially staffed and created for this purpose, the maximum of practical experience under conditions simulating as closely as practicable those to be found in the combat theaters. We stress in our unit training the vital importance of resourcefulness, ingenuity, improvisation and adaptation, and the use of field expedients. I am proud of the results achieved and feel confident that our individual Ordnance technical experts and our trained Ordnance units have a sound working knowledge of their jobs gained practically by "doing." Wherever they have gone in the various theaters they have performed their vital functions successfully and have reflected credit upon the Ordnance Department.

AMONG the many steps taken in our endeavor to solve the Ordnance training problem was the creation, early in our expansion program, of a Civilian Advisory Council composed of distinguished educators and industrialists, whose function was to give counsel and advice to the Military Training Division. The Council is composed of the following members: Dr. K. T. Compton, president, Massachusetts Institute of Technology; Dr. Robert E. Doherty, president, Carnegie Institute of Technology; J. E. Johnson, director, War Service Training, General Motors Corporation; Dr. H. P. Hammond, dean, School of Engineering, Pennsylvania State College; Dr. A. R. Stevenson, Jr., assistant to the vice-president, General Electric Company; Dr. I. C. Crawford, dean, College of Engineering, University of Michigan; Dr. A. C. Willard, president, University of Illinois.

The assistance of this nationally prominent group has been most valuable, and we are deeply grateful for their outstanding contribution to the success of the Ordnance training effort.

EDITOR'S NOTE.—In an article on "Education in Armament" in the January-February 1944 issue of ARMY ORDNANCE (Vol. XXVI, No. 142, p. 72), General Kutz wrote:

"There is not, nor has there been, a static quality in Ordnance training; on the contrary, it has been extremely sensitive to the needs of the line in the field, which is its ultimate mission of service. New doctrines and new techniques which have been proved in combat theaters are incorporated promptly into all courses of instruction and training programs. Our courses of today are quite likely not the courses we will be teaching tomorrow, but as of today they represent the latest thought and experience on a given subject."

The Automotive Training Program

Industry's Development of Technicians for Vehicular Maintenance

J. E. Johnson

MUCH has been said and written about the splendid coöperation between Ordnance and industry in the program of plant conversion, engineering, and production of war material for use by our armed forces. Relatively few people are aware of the magnitude of the training task and of what has been accomplished by Ordnance and industry-sponsored training programs by converting our peacetime training organizations and facilities for mass instruction on war products.

Early in January 1942, the automotive industry recognized that training might be necessary to help maintain at peak efficiency the weapons and vehicles which we would build for war. Contact was immediately made with the training divisions of the Army and Navy to determine where, and on what war products, such training assistance might be needed.

Through the Automotive Council for War Production, located in Detroit, the directors of training of the various automotive companies were brought together to discuss the broad phases of the problem, and plans were laid so that we could all work together to achieve the proper training of men sent to us from the Army and Navy in the shortest possible time. Necessary arrangements were made with the coöperation of the military training divisions for us to meet the officers in charge of their training installations, and visits were made to Aberdeen Proving Ground, Md., Fort Knox, Ky., Camp Hood, Tex., Great Lakes Naval Training Station, Ill., and many others, so that we might learn the kind of job to be done and meet the training objectives set up by the armed forces for the men we were to instruct. Liaison between Washington and Detroit was then established, and the program was on its way. We started in January 1942, and were training our own instructors so that we would be ready for the students, who began to come in early in February.

As in the war production program, the training organizations of the industries dropped their normal competitive attitude and worked together on the job to be done. We made visits among our schools, coöperated in course design, worked out manual information together, and helped train instructors, parts men, and technicians for overseas duty. I cannot speak too highly of the fine teamwork which we have experienced throughout the program from the directors of training in Ford, Chrysler, Continental, Packard, and many others of the industry's training and service organizations. At the same time, we must express our appreciation to all the officers in the training divisions of the armed forces whose leadership and support have been largely responsible for the results attained.

To give a clearer picture of this mass training by industry, I would like to show what has been accomplished by one of the major companies in the automotive field; namely, General Motors. In doing so, it is my sincere hope that I will not create the impression that we have done a better job or have done more than our share in the war products training program. I am sure that the other companies have excellent schools and have trained equally as well on their war products, but I can best present our own program, because it is the one I know most about, and I can deal with the facts in connection with it.

IN January 1942, General Motors created a new department designated as General Motors War Products Training Service, to function under the direction of the vice-president in charge of engineering. The central office staff of this training service was made up of a group of specialists selected because of their peacetime experience and its relation to wartime problems. This made available to the armed forces considerable experience and knowledge which would otherwise have taken months to acquire.

On February 10, 1942, two schools were started simultaneously. The first was the Diesel tank engine school for twenty-four instructors, requested by the Armored Force from Fort Knox, and conducted at General Motors Institute at Flint, Mich. The second was our Oldsmobile gun school, teaching the 20-mm. and 37-mm. aircraft guns, with thirty students at Lansing, Mich. This course grew until, by the end of 1942, 550 men were being trained at one time and it included the caliber .50 and 75-mm. guns. We have trained officers and enlisted men from the Army, Navy, and Marines and have graduated a total of 7,200 men in this school. The Frigidaire and Acceptance Corporation Divisions coöperated with Oldsmobile in the training on the caliber .50 gun.

A résumé of the scope and diversification of this training by General Motors divisions is given below. Each school is covered briefly: The Allison Engine Division has trained more than 8,700 civilians and Air Forces students on the Allison liquid-cooled engine. In addition, this division has 7 mobile units in the United States and 4 abroad which have trained more than 35,000 men. Aero Products Division, Vandalia, Ohio, has trained more than 1,300 men on the Aero-prop constant-speed propeller and at present is developing a new course on the constant-speed, dual-rotation propeller, with a substantial expansion of their present school. The General Motors Truck Division trained a total of 3,175 men on the 6x6 engine chassis and is at present conducting a school on the 2½-ton amphibious truck.

A Pratt & Whitney aircraft engine school has been operated by Buick and has trained a total of 2,700 men. It was the first school in the second district of the Army Air Forces Technical Training Command to receive the efficiency banner for "outstanding endeavor of its personnel and excellence of performance in assigned tasks." Pontiac Motor Division has conducted an antiaircraft-artillery school for the Army, Navy, and Coast Guard. This school is now being taken over 100 per cent by the Navy, and 1,500 men have been trained by this division. The Chevrolet Motor Division has operated three schools. Its Pratt & Whitney Engine School

Mr. Johnson is director of War Products Training Service, General Motors Corporation. This is an address delivered at the Ordnance Training Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

in Detroit is set up to train 75 mechanics every week, and to date has turned out 3,100 graduates. A second school was operated by Chevrolet on an armored car engine, and has been attended by 536 Ordnance trainees. Another school on this unit gave chassis instructions to groups of Army mechanics, and over 1,000 men completed this course. The Cadillac Motor Division has operated two schools for the Ordnance Department at the General Motors Institute, one on the transmission and transfer unit for the M5 light tank and the other on the Cadillac tank engine. Cadillac was one of the first divisions to set up a training school and has trained over 2,700 men on these two units.

THE General Motors Institute in Flint trained men on different types of General Motors engines, and here the Detroit Diesel Engine Division's 2 schools on the Diesel tank engine and the Gray marine conversion engine have trained 1,885 and 1,373 men, respectively. Navy and Coast Guard schools on 5 types of naval amphibious Diesel engines have graduated over 890 instructors and mechanics. Beginning July 19, 1943, a new course designed to train naval engine officers was opened at General Motors Institute. This course covered Diesel engines used in amphibious landing craft, including those of other manufacturers as well as General Motors engines, and has graduated 190 students to date. The General Motors Institute also trained 381 men from the Ordnance Department on armor-plate welding.

Other training schools operated by Cleveland Diesel, Delco Appliance, Delco-Remy, and Electro-Motive Divisions have trained approximately 4,000 men for the Army and Navy. The training has been completed and the schools transferred or discontinued.

Delco Appliance Division trained 193 men on the M5 and M6 antiaircraft directors and the school was transferred to Aberdeen Proving Ground. Eastern Aircraft started a school recently and 115 men have been trained to date on the FM-1 fighter plane for the Navy. At the Detroit Transmission Division's mechanics' training school, 1,900 men have received instruction and have been graduated on a course covering two types of military-vehicle transmission.

During 1942, we developed fifteen schools, and at the end of that year, our daily attendance totaled more than 2,000 men. We reached our peak in June 1943 with 22 schools having a daily attendance of over 2,800 men, and we were graduating them at the rate of over 3,300 men a month. By the end of 1943, we had trained over 39,000 men, over 50 per cent of whom were Ordnance soldiers.

To supplement the work of General Motors war products training schools, field representatives from many of the divisions, as the need arises, are assigned to training activities at Army posts and naval training stations. At present, there are approximately 600 representatives in the United States. In addition, over 200 technicians and parts men have been trained for the General Motors overseas operations. These men are now assigned abroad with the Army and Navy. Their training covered not only our own war products and our system of parts distribution and warehousing but those of several other manufacturers as well.

In conducting this training program, it often became necessary to design courses on products which we had never built before and which were also new to our training organization. We were fortunate in being able to use well-established practices and methods which had been developed for the training of employees in peacetime.

A given course of training results from a given need for specifically trained men. Let us assume, for example, that the Army needs trained Diesel-engine mechanics. The Army is best qualified to state what will be required of these mechanics—exactly what they are expected to do. Therefore, it should be represented at the planning conference which sets up the course. The manufacturer of the Diesel engine, on the other hand, is best qualified to state the operating requirements of his engine; therefore, he also should be represented at the planning conference. Since the effectiveness of the whole job will depend upon how the subject matter is organized and presented, training specialists should likewise be represented at the conference. When the representatives of these three groups meet together, the general specifications of this training program can be established and agreed upon so that the objective will be met. The detailed design of each part of the course as developed by the planning committee is then assigned to specialists who are given the job of writing instructors' outlines and students' guides on the subjects with which they are most familiar. The outlines and training aids prepared by these men may be likened to the blueprints prepared by engineers or commercial designers. The work of each designer must be carefully coördinated with that of the others. This is usually accomplished by a reviewing process whereby each man may read the others' outlines.

The course should next be tested, much as a commercial product is tested in the laboratories or on the proving ground. The "trial run" may disclose some imperfections which must be revised and retested. With the revisions completed, the course can now be put into production. Under production training, an established number of students enter the class each week, and soon the same number are graduated each week. When the course is completely organized, and instructor's outlines and training aids have been developed, the school proceeds on a production basis with the assurance that the men are being trained to meet the original objectives established by the planning group.

TO give a comprehensive view of the amount of organizational work and detail necessary to carry on a program of this kind from the standpoint of all types of training aids used in our schools, it must be recognized that war products training courses differ from ordinary classroom methods. The object of these schools has been to train technicians as rapidly as possible, and this calls for intensive training courses conducted in shops and laboratories, with the men working most of the time on the equipment. Lectures have been practically eliminated. We have dealt with the essential things the men need to know and have tried to prepare them in the simplest possible manner. This has meant the use of much special equipment—special tools, charts, models, motion pictures, strip films, and manuals.

A great many of our staff and supervisors of training served in World War I, and we are all very proud of that experience. As most of us could not enter active service in World War II, we hope that we have in our small way helped our troops to go into action on the battlefield better trained to use and maintain the weapons and equipment we have been privileged to produce for war. When victory is won and these young men come back again there is also the hope that, as they resume their postwar lives, we may have helped their future by meeting their training needs of today.

New Army Vehicles

Developed by the Coast Guard for beach-patrol work, the "Invader"—new version of the jeep, shown above—carries 10 men instead of the regular model's 4, and its oversize tires give good flotation in sand. The new Ordnance-designed 8-ton, 6-wheeled armored reconnaissance car M8, below, mounts a 37-mm. cannon and a caliber .30 machine gun (Acme photos).

The Colleges in War and Peace

Their Value in Training Reserve Officers and Technicians

Dr. H. P. Hammond

AS the most important function of American colleges, whether in wartime or peacetime, I should place the production of young men and young women having trained intelligence. Whatever serves the Nation as a whole also serves the Army; no nation that lacks a plentiful supply of intelligent, trained young people can long sustain the effort of modern warfare.

To give some idea about the magnitude of the services of this sort that are rendered in times of peace, I shall refer to the product of our engineering colleges. These institutions, about 160 in number, normally enroll approximately 125,000 students and produce each year about 15,000 graduates. This is by far the largest number produced in any country of the world, both as measured on an absolute scale and as expressed in proportion to the total population. Russia was gaining on us rapidly in this respect prior to 1939, and I venture to express the opinion that it is largely because of this growth of the Russian educational system that our ally is able to conduct its astonishing campaigns.

But it is the United States above every other nation that produces the greatest number and the best-trained young technical recruits for industry and for the military services. It is from these recruits that the chief supply of administrative and executive leadership on which our industrial system rests is being drawn. More than half of all engineering graduates find themselves within a comparatively short time in positions principally administrative in nature; fewer than half are concerned chiefly with purely technical responsibilities. I do not hesitate to assert that it is this group that is largely responsible for the production record which industry and business have made during the past three years.

The second great service of the colleges is in supplying the Army with officer material. It is a fact well known to some, but not perhaps to others, that a large majority of Reserve officers available in this country at the beginning stages of a war are the graduates of a group of civilian colleges. Eight of these institutions (not including the United States Military Academy) are operated on a military system. These are Virginia Military Institute, the Citadel, Pennsylvania Military College, Norwich University, Clemson College, Texas Agricultural and Mechanical College, Virginia Polytechnic Institute, and North Georgia College. It is a fact of passing interest that six of these institutions are below the Mason and Dixon Line. The other institutions which produce Reserve officers are the 50-odd land-grant colleges and universities and a smaller number of privately endowed colleges and universities.

It is interesting to note that these institutions graduate each year in times of peace approximately twenty times as many officers (Reserve Officers' Training Corps advanced-course graduates) as does the United States Military Academy; that is, about 9,000 R.O.T.C. graduates each year who are commissioned as second lieutenants in the Reserve. I have been informed that, at the present time, of approximately 560,000 officers in the Army, about 15,000 are Regular officers. I have also been informed that about 8,000 of these officers are graduates of the United States Military Academy. Of the remaining officers, probably more than 100,000 are R.O.T.C. graduates of the colleges and universities, including the 8 military schools mentioned above.

This service is indeed an indispensable one to the Army. It is from this group that a very large fraction of our present officers of middle rank, say from first lieutenant to lieutenant colonel, have been recruited. Of course, these young men are not fully qualified officers when they are graduated from college, but they are much further along the road to military competency than are other officers drawn from civilian life. I think it is safe to say that it would have been impossible to discipline and train our wartime Army in the time necessary for the present development without this large group of civilian college graduates.

To summarize, then, I may say that in their ordinary functions American colleges and universities perform two vital services for the Army: first, and the more vital of the two, is the production of the largest proportion of trained men and women that is available to any nation of the world for service in a time of emergency; and, secondly, the production of a reservoir of Reserve officers from which to draw a substantial proportion of the total officer supply needed by a modern Army.

WHAT has just been said applies, of course, to times of war just as it does to times of peace. But in addition to these basic functions, American colleges and universities are now assuming additional duties. These services are performed in the several special training programs now in progress. By and large, we have not made the mistake this time that we did in the last great war of using the resources of the American colleges in training Army personnel at the technician level. Training of this type is now being done chiefly by the Army itself at Army posts, and, incidentally, I believe it is better done than it would have been in civilian institutions.

The facilities of the colleges and universities are being used—though not at capacity—for training at higher levels. Chief among these training programs is the Army Specialized Training Program. The enrollment in this program in October totaled approximately 130,000. This included students of medicine, premedical, area and language, psychology, basic and advanced engineering.

This program has been the center of so much discussion that it may be worth while to outline some of its features. At the start, trainees were selected from Army personnel. At present, boys straight from high school are being selected. All students, either before they enter the program or when they reach the age of eighteen, take thirteen weeks of basic military training in an Army camp. All students of the program are required to pass the Army general classification tests with a score of 115 or better; the average score of all recruits is 125. Thus, Army Specialized Training recruits

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come from the top seven per cent of the Army in point of general intelligence and scholastic aptitude. They must also qualify physically and, presumably, must have had the essential secondary or collegiate preparatory scholastic training.

The basic engineering curriculum in which about half of all the Army Specialized trainees are enrolled is of three 12-week terms, or approximately nine months' duration. The curriculum of this phase, which is common to all engineers but deviates in the last term for certain other students, includes mathematics, physics, and chemistry as sciences; English, history, and geography as general studies; and a brief course in engineering drawing. The curricula of the advanced phase are of either three or four additional terms' duration. The advanced-phase curricula include electrical engineering, communications and power specialties, civil engineering, mechanical engineering, and, until recently, chemical engineering. Advanced-phase curricula are highly concentrated in science and engineering and lead to such specialties as ultrahigh frequencies, communications networks, servomechanisms and control devices, and radiation and propagation. The courses of the seventh term of this curriculum are of postgraduate nature. It is remarkable, in the light of ordinary college experience, that students could be prepared for such a high degree of specialization in a year and a half of college work.

I shall not attempt to discuss the premedical, area and language, and psychology curricula because I believe their purposes will be understood from their designations. Some comments on the engineering curricula, however, may be of interest.

FIRST, they are having an important influence on American engineering colleges. As the load of civilian instruction decreases (it is now less than one-half of its prewar magnitude and is apparently destined to undergo a still more drastic shrinkage) the work of the engineering colleges has been directed more to the Army Specialized Training Program. This is a much more specialized and concentrated program than normal engineering curricula. There is far less curricular diversification and comparatively little time is spent on general studies. It will be noted that there are no curricula in the mineral industries, none in industrial engineering, and the curriculum in chemical engineering is now disappearing. Thus, we have a concentration of college faculties in a restricted field. Dislocations caused by the nature of A.S.T.P. have been numerous and severe. But the colleges have adjusted themselves to the new situations promptly and, on the whole, effectively.

Secondly, the work of the Army Specialized Training Program is conducted under a system of inspection, partly by the military authorities and partly by groups of civilian educators previously experienced in inspection work under the Engineers' Council for Professional Development. It is the testimony of these inspecting groups that the American engineering colleges have adapted themselves with surprising facility to the new situations that confront them.

Thirdly, the work of the Army Specialized Training Program is conducted at moderate cost. I am told that it is costing, on the average, less than $1,000 per trainee per year including instruction, subsistence, and other expenses. It would cost about fifty-four per cent of this amount if the soldier were merely a private in an Army camp.

The second important Army training program is that conducted for the Army Air Corps. This is much briefer and of less advanced nature than is the Army Specialized Training Program. Cadets enter and leave the colleges at frequent intervals, and the trainee population is a constantly shifting one. About 66,500 trainees were enrolled in this program in October.

In addition to these programs, conducted for strictly military purposes, many of the colleges are conducting other special programs which are important—though less directly related to Army requirements. I refer here, in the first instance, to the courses of the Engineering, Science, and Management War Training Program of the United States Office of Education in which 223 American colleges and universities are participating. During the past 3 years, over 1,250,000 individuals have enrolled in this program. These courses are brief, intensive, and directed toward definite technical aims. At present, all but fifteen per cent of them are being conducted for employees of war industries. They are, therefore, essentially upgrading courses and supply the additional skills, knowledge, and ability needed as young men and women advance step by step to higher positions in the industrial system.

All this is in addition to work being done for the Navy under the Navy College Training Program and other special courses in which approximately 17,000 trainees are enrolled. None of these figures include Army and Navy personnel in training under military staffs on properties rented by the services from civilian institutions.

IN times of peace, the total population of the American colleges and universities is somewhat more than 1,000,000 students. The population of the engineering colleges is about one-eighth of this total. At present, there are approximately 130,000 A.S.T.P. trainees and 66,500 Air Corps cadets, as well as a somewhat smaller number of other special training groups (including Navy trainees) in attendance, totaling, in all, about 212,500 trainees. In addition, colleges and universities have a residuum of their regular student body which, because of the large number of women students, probably totals nearly 500,000. Among this number there are from 30,000 to 40,000 engineers.

American colleges and universities are also conducting engineering, science, and management war training courses for a very large number of students, probably about a quarter of a million at present. While no one knows the statistics of attendance accurately (because they are constantly changing) the general order of magnitude of the training programs in progress is probably indicated reasonably well. It is evident, therefore, that these institutions in general and their engineering schools in particular are rendering a service of great magnitude and importance to the Army and to the Nation at large.

Study is now in progress seeking to assist the colleges and universities, including the engineering schools, through a period of drastic readjustment which must come in the immediate postwar years as well as to aid them in the longer period of development which lies ahead. Study is also being given to the future of the R.O.T.C. program, especially in relationship to the possibility of universal military service. It is of primary concern to the Nation as a whole, both now and in the future, that these institutions shall pass through the throes of the present in such condition that they can take up the burdens of the future with their facilities, staffs, and resources in condition to proceed along the path of national interest which lies ahead.

Combat Knowledge

Realistic Training Methods Speed Up Ordnance Instruction

Dr. Robert E. Doherty

WITH my colleagues on the Civilian Advisory Council, I have visited the Ordnance School and Ordnance Replacement Training Center at Aberdeen Proving Ground, Md., the Tank-Automotive Center at Detroit, Mich. (now known as the Office, Chief of Ordnance, Detroit); the Fort Crook, Nebr., Automotive School; and the Red River Ordnance Unit Training Center at Texarkana, Tex. Visiting these centers involving more than 20,000 trainees has given me some deep impressions.

I wish to make a few observations, especially regarding the work at Fort Crook and Red River. At Fort Crook, I found extensive training of automotive technical specialists of all kinds, ranging from canvas workers and cobblers to highly trained engine experts. I found not only instruction in individual manipulation but also some effectively organized shop units where the trainees learned teamwork.

I was especially impressed, as were all my colleagues, with the unit training at Red River. At this center, where all training is on the unit basis, there was a new element—a high degree of realism. Located at a general depot in an extensive area of varied terrain, the Red River training center has great advantages—transportation facilities, the availability of all manner of equipment, and the opportunity of practical technical experience in base shops, of repair work under field conditions, and of basic training of soldiers under circumstances simulating those of actual combat. For illustration, from among a number of items, there was the infiltration course, street-fighting course, mental-conditioning course, etc. I was quite near enough to some of these activities to get myself "mentally conditioned" in two or three instances, especially in the attack on the village. I was in the village! Much of the work just referred to involved individual training, but the training was received by the individual as a member of a group.

Units are also trained to perform their mission as a team. Whether it was in a base shop or in the field, on the move or in bivouac, or perhaps working under blackout conditions —as we found one medium repair unit doing when we visited it in the night—under all these conditions, we were impressed by the realism and the effectiveness of the work.

One of the most evident reasons for this effectiveness was the ability of the instructors. Whether it was in the shops or the field, in bayonet practice, battle experience, or on the rifle range, this element of capable leadership, clearly respected by the trainees, was always in evidence. I can testify from personal experience on the rifle range as to the quality of instruction. My scoring a bull's-eye on the first shot with a Japanese Arisaka 1905 rifle and my firing of a bazooka with no injury to myself or casualties among my colleagues or, so far as I have learned, among the Army personnel, ought to be convincing evidence of the effectiveness of the instruction I had! Seriously, however, superb leadership in training was one of my outstanding impressions.

The characteristic which distinguishes Ordnance training from all other training with which I am familiar is its intensive nature. Much has to be done in an incredibly short time. The method of solving what might seem, on first thought, an impossible task in view of the extremely short time available for training is General Kutz' "Bull's-eye Theory." If you will visualize a target with two rings around the bull's-eye and then label the bull's-eye "must-know," the first ring "should-know," the outer ring "nice-to-know," you will have a picture of his theory. There was no time for either "should-know" or "nice-to-know." All training must be directed toward the bull's-eye, "must-know."

This theory obliged the planners of the program to separate and clearly define what the trainee *must know* when he finishes the course. Methods were then worked out and instructors trained to teach just that and nothing else. In this program I think General Kutz and his associates not only have done a magnificent job for the Army but also have made a significant contribution to education in general.

The conclusion of the civilian group which I represent is that the Ordnance training program is a job well done. The only criticisms our group had of the program were: (1) that greater time should be made available—six months instead of the original thirteen weeks, later increased to seventeen weeks; and (2) that there was no way in which the effectiveness of the training in the actual theaters of operation could be observed directly by representatives of the Ordnance Training Division so that appropriate measures could be taken to correct any deficiencies—in other words, to determine what is good and what is not. However, decision on these questions is not, I understand, within the province of the Ordnance Department itself. The Civilian Advisory Council nevertheless registered its opinion regarding these matters. Our general conclusion is that, under these restrictions, the Ordnance Military Training Division is doing a grand job.

Editor's Note.—E. S. Webster, director of apprentice training at Watervliet Arsenal, wrote in the March-April 1944 issue of Army Ordnance (Vol. XXVI, No. 143, p. 299):

"In 1940, a survey of American industry conducted by the American Society of Tool Engineers indicated a shortage of 1,500,000 skilled mechanics such as machinists, tool and gage makers, designers, etc. Competent authorities emphasize the importance of the postwar retooling job that will be required to return war plants to peacetime pursuits. Greater emphasis will be placed on new and improved methods, tools, and machines for new products and on reducing costs to meet the keen competition expected. It will have to be done fast if industry is to absorb the millions of returned service men as rapidly as will be desirable.

"It is felt that sufficient men have not been trained to make up the above-mentioned shortage, much less prepare for the future. A big job lies ahead, and industry should prepare to meet it; it should be resourceful enough to work toward the desired objective with the means at hand."

Dr. Doherty is president of Carnegie Institute of Technology. This is an address delivered at the Ordnance Training Round Table Conference of the Twenty-Fifth Annual Meeting of the Army Ordnance Association, held at the Waldorf-Astoria Hotel, New York City.

Ordnance Instruction

The Conversion of Civilians into Trained Armament Technicians

Col. W. R. Slaughter

THE task of the Ordnance Department when mobilization came was twofold—to convert civilians into soldiers and then to train the soldiers as technicians. It was a stupendous task, and upon its success depended not only the life of our fighting tools but, more important, the life of every soldier who used them.

Complicated though the job appeared, the requirements for this training task differed from any similar undertaking only in degree. The numbers of men involved were greater; the technical details were more complex; the training time available was shorter; and in the early stages, training tools, classrooms, instructors' textbooks, and even weapons, vehicles, and instruments were nonexistent or very scarce.

The basic training methods utilized were still much the same as were available then and now to our universities and to our industrial educational institutions. Fundamentally, those methods can be reduced to explanation or "telling," demonstration or "showing," and application, which is "doing." These age-old methods were continued, but, of necessity, special emphasis had to be placed on the more practical steps; namely, "showing" and "doing." To accomplish this, it was determined that the lecture, or "telling" method, which is so important in academic education, had to be somewhat restrained, and, where employed at all, it was to be implemented with visual aids of various kinds: charts, films, models, staged demonstrations, and the use of note-taking aids, until it resembled demonstration more than lecture.

Thus, Ordnance training, utilizing adaptations of tested methods, took on more of the aspect of a foreman demonstrating a task to a new employee than that of a teacher explaining a lesson to a class. The outer form of instruction remained academic; classes were large; an examination and grading system was employed. Yet throughout the entire program it was evident that the accent was on "showing" and "doing" rather than on "telling."

During all phases of training, time was the most important factor, and emphasis was placed on speed. To crowd as much skill into a soldier-technician's performance as possible in the short time available became the prime requisite. To accomplish this end, our program was forced to utilize all avenues of entry to the mind—hearing, sight, touch, smell, and even taste. In line with the emphasis on showing and doing, sight is the most important. Sight needed less translation and interpretation than the other senses. Visual experiences are received more rapidly and retained more readily than any others. That seeing is believing again proved indisputable.

It is not suggested that the Ordnance approach to visual education is new. But what is new is the fact that never before has visual education been used so extensively, and never has it been so vital to educate and train in such a short time. Our enemies are not awaiting our convenience.

Visual aids were developed and used to bring small, detailed objects within the grasp of 100-man classes. Visual aids were used to teach maintenance of tanks when no tanks could be spared for training. Visual aids also were used to challenge the ofttimes wandering attention of the not-too-willing soldier in a specialized study for which he had had no previous preparation in civilian life. These aids, too, assisted the new instructor and saved him many a labored sentence. The psychological effect on the trainee was excellent as it also aroused a certain amount of curiosity, which, under the lecture system, might have remained forever dormant.

VISUAL aids include training films with all of the facility for action and picturization of which motion pictures are capable. In 1940 the Army produced a grand total of 21 complete training films, and in 1944 it is expected that production will exceed 700 films. They have only one drawback—they are expensive in time and money. Other aids are film strips—a series of still pictures which may be projected on a screen for a class of 1,000 men and afford opportunity of studying at length any function which may not be clear in the mind of a student.

Transparent plastic materials are used in the construction of cutaways. A plastic carburetor is constructed as an exact reproduction of a standard carburetor, but, being transparent, it permits a clear view of carburetor action when used on an engine. Other plastic units include a complete cooling system, distributor housing, transfer case, air cleaners, fuel pumps, and so forth. In addition, many cutaways have been used with plastic windows which permit the action of lubricants in the unit to be observed while driven by an electric motor.

Giant-scale visual aids are extensively employed as their use permits efficient demonstration of small items to large classes. Giant micrometers have been constructed which are twenty times the normal size, and instruments, dials, and panels have been enlarged up to ten times. Use of electrically driven complete cutaways permits the student to observe action of a particular unit or part being studied and the operation of other units in relation to the one on which attention is being focused. At the other extreme, small models of trucks, tanks, and guns in sand-table displays are used to demonstrate tactical and supply problems.

Not the least among visual aids are the large, colorful charts which show every conceivable function of obscure items of equipment and which exploit the established fact that one picture is better than a thousand words. By means of the modern silk-screen process, thousands of these brilliantly colored charts are manufactured which are distributed to training establishments and troops throughout the world so that every classroom and training area may be provided with the necessary illustrations of the subject matter being taught.

It is possible for an instructor to have too great a respect

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for visual aids and to fall into the error of believing that the greater number of visual aids he introduces into his course the more effective his instruction will become. Actually, the use of visual aids can be overdone, and, when too many aids are used, the novelty wears off. Thus a great deal of the power of the aids to attract attention is dissipated. One of the purposes of visual aids is to obtain emphasis, and it stands to reason that if you emphasize everything, you virtually emphasize nothing.

It was also necessary, of course, to establish *what* should be taught, then *how*, and *with what* to teach it. The system evolved was essentially the Army system of training, but added to its disciplined pattern were the experiences of American education and American industry. It would have been impossible to demand that our students have background knowledge which our universities consider essential prerequisites. It would have been equally impossible to demand apprenticeship or prior experience as might possibly be the case in industrial education.

In thousands of instances, for example, clerks and accountants have become skillful bomb-disposal experts or repairmen of optical instruments in the space of a few weeks. This phenomenon could be accomplished only by carefully selecting the information that was essential to the performance of the detailed job for which the individual had been selected.

"Course design" is the formal term applied to the task of selecting the information which must be taught in the allotted time—the "must-know" information. The end product, that is, the degree of skill which it is desired that the soldier-technician attain, is determined in advance. Then all the "should-know" and "nice-to-know" information about a certain subject is stripped away, leaving only that information which the student must know if he is to perform the task to which he is to be assigned at the conclusion of his formal training.

That is the essence of course design, and that system of determining what must be taught, with the accelerated use of visual aids, has been our solution to the problem of producing highly skilled technicians in less time than it had ever before been thought possible.

SPECIALIZATION has been carried to a high degree, a conclusion which is obvious in light of the program outlined. There are comparatively few over-all artillery experts in Ordnance, but there are many experts in the maintenance and repair of specific guns. Likewise, there are few all-around mechanics, but many men who are highly skilled in particular mechanical jobs. From the standpoint of our needs there was no other course open in light of the numbers of men to be trained and the time in which to train them. It became necessary to depend on a broadening of skills and techniques and upon subsequent cross-training and the factor of experience which each individual technician obtained in the field.

The system is not a static one, of course. The constant development of the tools of modern war and the new battle tactics encountered at the fronts make it imperative that instructional programs be redesigned frequently. Testing, inspections, battle reports, and new techniques keep ever alive and ever flexible the training program.

There were numerous other problems. There was a lack of classrooms and instructional buildings, and at the beginning it was often necessary to conduct classes out of doors. There was a lack of instructors, and one of the initial problems was complicated by the need for training instructors concurrently with the training of the thousands of new technicians. There was also the replacement training center, unit training, and all of the attendant problems. It is one thing to train individual technicians in a school; it is another thing to train a group of technicians to function as a team—and it is as a team that Ordnance units function when they reach the combat zone.

But whether it was at the replacement training center where replacements are trained for overseas units or in the training of a unit or an individual at one of our schools, the same basic factors were applied. The end-product desired was determined in advance, then the instruction was tailored to produce the end product in the limited time available. By the use of visual aids on a scale heretofore never attempted —by subordinating the "telling" phase of learning in favor of "showing" and "doing"—and tying the whole program together with Army discipline, the task is being accomplished.

ORDNANCE training methods, therefore, are at one and the same time old and new. Time-tested methods have been built upon an Army framework, but slightly different adaptations of those tested methods have been introduced. Elements of highly distilled visual education have been injected, and, by keying the entire system to an accelerated tempo, the job is being done. The reports from the many overseas combat zones indicate that Ordnance training has indeed succeeded.

Technicians are working well under most adverse conditions in sandstorms, blackouts, snow and ice, and steaming jungles. They are hardened, toughened soldiers, and they know their specialties. The units have the teamwork and *esprit de corps* so necessary to the successful completion of their mission. This can end only in final victory, and the educators and industrialists who have shared in this effort can well be proud of their contribution to the final product.

EDITOR'S NOTE.—In an article on "Training the Ordnance Soldier," in the September-October 1942 issue of ARMY ORDNANCE (Vol. XXIII, No. 134, p. 272), Brig. Gen. Julian S. Hatcher, then chief of the Ordnance Military Training Division, wrote:

"Every one knows of the vast industrial achievements of Ordnance, but apparently few realize the extent to which Ordnance soldiers form part and parcel of our fighting forces. This is a mechanized war, fought by machinery and instruments of many kinds. Most of these are entirely different from anything found in civil life; they are complicated in construction; they require skilled understanding to operate and skilled training of the highest order to maintain. It is the job of the Ordnance soldier to be on hand ready to repair these mechanisms of war when for any reason they become so damaged or out of adjustment that the soldiers who use them are helpless to put them in order again.

"In our homes today we have vacuum cleaners, radios, electric refrigerators, and other appliances which are simple to use but far from simple to repair when they get out of order. In fact, the average man is helpless when his radio refuses to function or his refrigerator to freeze—all he can do is send for the service man. The Ordnance soldiers are the 'service men' of the battlefield. Their knowledge must begin where the ordinary soldier's knowledge ends, and they must know how to repair the hundreds of complicated articles found in a modern campaign."

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MAY-JUNE, 1944

Month by Month

Machinery for Contract Termination.—To assure that adjustments in the Army procurement program are made with full consideration of the effects on the civilian economy as well as the fundamental factor of military necessity, a new policy review has been established in the Army Service Forces headquarters and the technical services that buy equipment.

The prosecution of the war demands that military production, on an over-all basis, continue to rise this year in comparison with last year. None the less, the successful accomplishment of industry and labor, working with the Army, to build up supplies of war material to a security level has now put production of many items on a replacement basis. The ability of various of our allies to produce certain needed items on a scale larger than was earlier thought possible also is a factor in trimming our own output at some points.

In terminating contracts, speed is essential to avoid uneconomic production of an item after the need for it has ended. However, as much advance warning as possible is given in order to make necessary adjustments. The War Manpower Commission is given prompt notification before a cut is actually made so that it can see to it that any labor released is efficiently absorbed. The new review system is designed to insure prompt and equitable consideration of the many factors entering into a termination program.

Under the War Department procurement regulations, whenever it becomes necessary to terminate certain contracts, the decision as to which ones to cut is governed by a wide variety of considerations of importance both to the prosecution of the war and to the civilian economy. For example: Is a plant in a tight labor area where any cut in employment would be readily absorbed or is it in a less critical area? Is the plant more or less efficient in the utilization of critical materials than others doing the same work? Are its prices economical to the Government or is it a high-cost producer? Is it well located geographically or is there a long haul over the country's hard-worked transportation systems? These and many other factors enter the problem, and as these are of differing importance in different situations, the net decision is one of military and business judgment.

When the responsible contracting officers and their staffs have evaluated the considerations in each specific contract included in a termination program, their reports will be subject to review by the special review board of the technical service involved. Each case will be reviewed when it involves more than one contractor and a sizable number of workers or amount of productive equipment. After approval by the chief of the technical service concerned, each board's decisions will be forwarded to the Commanding General, Army Service Forces, for further comment in the case of privately owned plants and final authorization in the case of Government-owned installations.

A topside review board in Army Service Forces headquarters will consider all cases and make recommendations to the Commanding General, ASF. This final board of review will discuss the problems involved with the other Government agencies responsible for procurement, and with the War Production Board and War Manpower Commission, so that final action may reflect the views of all agencies.

The headquarters board of review consists of Brig. Gen. Hugh C. Minton, director of the Production Division, ASF, chairman; Brig. Gen. T. D. Weaver, director of Industrial Demobilization, ASF; Col. L. A. Denson, director of Requirements Division, ASF; Col. D. N. Hauseman, director of the Readjustment Division, ASF; and James Mitchell, director of the Industrial Personnel Division, ASF.

Chairmen of review boards in the seven technical services are: Brig. Gen. Hermon F. Safford, Ordnance Department; Col. DeTreville Ellis, Quartermaster Corps; Col. Frederick G. Sherrill, Corps of Engineers; Col. Leonard M. Johnson, Chemical Warfare Service; Brig. Gen. Burton O. Lewis, Transportation Corps; Col. Conrad E. Snow, Signal Corps; Lieut. Col. H. F. Currie, Medical Corps.

Renegotiation Reserves.—Reserves for renegotiation refunds which war contractors may set up and show in their statements and annual reports are not to be regarded by Government renegotiation officials as binding on contractors, according to a ruling by the Joint Price Adjustment Board, representing the six Federal renegotiation agencies. The chairman of the Board, Joseph M. Dodge, has made the following statement in this connection:

"The increasing practice of providing such a reserve is to be encouraged as a matter of sound accounting. The amount established in individual cases will vary widely, depending upon the policy of the particular contractor. It may be more or less than is actually needed when the renegotiation of the fiscal year for which the reserve has been set up is concluded.

"It would be manifestly unjust for the contractor to be

bound by the amount of it to affect the renegotiation proceedings. The renegotiation officials are instructed that such reserves are not to be considered directly or indirectly in connection with the determination of any price adjustment to be refunded to the Government under the terms of the renegotiation statute."

The six Federal renegotiation agencies are the War, Navy, and Treasury Departments, U. S. Maritime Commission, War Shipping Administration, and Reconstruction Finance Corporation. Agency headquarters are in Washington, D. C.

Ordnance Modification Plants.—The Army Ordnance Department has solved one of the most pressing mass-production problems in the entire war effort through modification plants that incorporate the newest design and engineering changes in standardized equipment. Large quantities of combat vehicles cannot be mass-produced if specifications are constantly changing; yet numerous design changes must be made in order to profit from battle experience and scientific progress.

SHORTPANTS THE SAGE
C'MO Will Gasner
AMERICAN ORDNANCE
NOW, JOE..JUST BECAUSE WE WON THIS BATTLE AINT NO REASON FO' YOU TO SPIKE Y'R ARTILLERY...YA MAY NEED IT AGAIN!

Ordnance is able to standardize and yet constantly improve combat vehicles at modification plants on both the East and West Coasts. To these plants are sent thousands of light and medium tanks, tank retrievers, jeeps, armored cars, amphibious tractors, bomb carriers and trailers, heavy wrecker trucks, and many other types of modern Ordnance automotive equipment in the building of which thousands of companies and millions of men and women have done their part.

The majority of all this equipment is destined for overseas shipment from various eastern and western ports—shipments under all kinds of circumstances and climates which must arrive in combat theaters in absolutely first-class condition, ready for immediate use. Modification of matériel in transit from factories to the battle zones is the Ordnance answer to the problem of how to maintain the world's greatest production by standardization of types and yet deliver individual units to the fighting forces with the latest improvements incorporated, as well as to make the changes to standard types necessitated by special battle problems.

When certain equipment is reported to have shown weak points here and there under fire, these weak points must be corrected by addition of more armor in vulnerable spots, more firepower, more mobility or maneuverability. In other equipment, changes in design have improved the product and these changes must also be made by the modification plant until they can conveniently be incorporated into the regular production lines. Costly and time-consuming changes in production lines are thus eliminated, as modification changes can be made without stopping regular manufacture.

Government Ownership.—According to Jesse Jones, Secretary of Commerce, our Government has spent probably twenty-five billion dollars during the past three years in building plants and facilities vitally needed for prosecuting the war.

A large share of our wartime expansion has been financed by the RFC. Through its subsidiary, the Defense Plant Corporation, it has authorized the expenditure of approximately $9,000,000,000 for the construction of plants and manufacturing equipment. In addition, it is spending large sums for the development and production of raw materials.

For instance, the Defense Plant Corporation has spent about $1,000,000,000 in expanding the Nation's steel production. Included are large plants at Geneva, Utah; Homestead, Pa.; and Chicago, Ill. Also, the Corporation has built 120 smaller steel plants and additions to privately owned properties. Title to all these is in the United States Government.

Nine plants have been built for the production of aluminum having an annual capacity of 1,200,000,000 pounds—more than that of all privately owned plants. In addition, 45 plants were constructed for fabricating aluminum. All this, owned by the Government, has cost $760,000,000.

In the magnesium field, DPC has invested approximately $430,000,000 in manufacturing plants. Private industry will own only about eight per cent of the total magnesium production of the country at the close of the war.

In rubber, the Government will have an investment of $625,000,000 in plant facilities. Such facilities are sufficient to manufacture more than 800,000 tons of synthetic rubber annually, which is one-third more rubber than we have ever used in peacetime.

The Government also has a substantial stake in the machine-tool industry. In fact, the RFC has so expanded this particular industry that it will own almost one-half of the country's machine-tool manufacturing facilities.

However, the biggest investment in manufacturing facilities has been made in the aviation field. For RFC has built and owns 521 plants for the production of aircraft, aircraft engines, parts, and accessories at a total cost of $2,700,000,000. This is ten times the value of privately owned investments.

The sum of $500,000,000 has been expended in building 50 plants to manufacture high-octane aviation gasoline. Twenty of these plants are owned by RFC.

It will cost $180,000,000 to complete the program of 3,800 miles of pipe lines. The most important of these is the big 24-inch line running from Longview, Tex., to Philadelphia and New York, a distance of 1,500 miles. This one line, recently completed at a cost of $95,000,000, will have a capacity of 300,000 barrels of crude oil a day. It is owned by the RFC and operated for its account by men in the oil industry.

The Baruch-Hancock Report

A Summary

VICTORY is our first and only duty, but just as we prepare for war in time of peace, so we should prepare for peace in time of war. Through preparation we visualize a prosperity, sound and lasting. We see, not merely civilian needs crying to be filled, but a world requiring the things we can supply—an unlimited market for our products.

Our specific assignment was to study the immediate demobilization policies which have to do, necessarily, with the stimulation of the war effort, since victory is the first essential, and with the preparation for peace to follow victory—to win the war and to prepare for peace.

In the development of this theme we find certain considerations to be of first importance. They include:

1. Getting us all back to work in peacetime enterprises. This may require a special authority under the Director of War Mobilization to give its entire attention to the problem of bringing jobs to all workers, with emphasis laid upon the returning service men and service women who are our first concern.

2. Taking the Government out of business by:

(a) Payments for work done and work under way. In connection with this phase of the problem, we have assembled a complete "Financial Kit" that should prove effective. The Government must pay its debts, and pay them quickly and fully, so that business will have its working capital freed for pay rolls and purchases of materials.

(b) These payments can be made with ample protection to the Government against fraud.

(c) Move out and store war materials from plants so as to make room for equipment and materials for civilian production.

(d) Centralize the control and disposal of surpluses of all types in such a way as to bring them into ready and effective use and insure orderly markets. This, too, may require a special administrator in the Office of War Mobilization.

3. A general tightening up of the industrial war front so as to finish the bloody business with finality, and thus be ready for peace.

4. Spreading acceptance by war contractors of the "Uniform Contract Article."

5. Place all war agencies under running review to cut them down as their work dwindles; also review of all war industrial controls.

6. Immediate extension of laws governing price control, priorities, and requisitioning, all three expiring this year.

7. Early engineering on public works to be ready if needed to fill in the valley of unemployment.

8. Provide credit means for those requiring it during the adjustment period, particularly for the smaller business groups and returning service men.

9. Prepare now for future action reducing taxes from war to peacetime levels, thereby providing necessary incentive for initiative and enterprise and stimulating employment.

10. Prepare an Emergency "X-day" Reconversion Plan to be used in the event of a sudden collapse of Germany so as to enable us to go on with our crusade against Japan and at the same time to prevent the dislocation resulting from lack of preparation. This phase of the broader plan is to be worked out by the armed services with the War Production Board.

Transition from a war economy to that of peace is not easy; nothing worth while is. In our reconversion we shall try, as this country always does, to cure the things that caused us worry and to strengthen the good; to hold to the proven but be ready to test the new. That is progress.

The frame of our operation shows the gigantic nature of the change-over. It affects every part of our economic life. Nothing comparable ever has been known before.

As one indication of the size of the job, about fifty billion dollars of the current annual production represents strictly war goods—that is, things which, when peace comes, we will stop making. This gap must be filled in large part by civilian production and services if we are to keep the needed volume of employment. The demobilization of the armed forces will come gradually. Their absorption by industry will be aided materially by several factors, the weight of which is not now clear; such as, the giving up of war jobs by many women; the retirement of older workers; the increase of travel and recreation time; the return of many younger workers to school; the resumption of college and professional training by many now in the services or in war industry; the renewal of many professional and service businesses that have stopped during the war; the starting of new enterprises; the business involved in meeting the needs of the world; reduction in the work week; the normal enforcement of child labor laws.

The net increase in employment in industry from 1937 to 1944 is estimated at 7,600,000 people. Considering factors mentioned above, the problem of demobilization, though difficult, is soluble if we create the atmosphere in which private initiative and resourcefulness—the traditional American spirit—can again take hold.

It is an easier task to convert from peace to war than from war to peace. With the coming of war a sort of totalitarianism is asserted. The Government tells each business what it is to contribute to the war program—just what it is to make and where it is to get the stuff out of which to make it. The planning and execution rest upon one over-all purpose and a single control. Patriotism exercises a strong compulsion.

With peace, the opposite becomes true. Each has the right to make what he pleases. Governmental direction and aid disappear. The markets become free and each individual is dependent upon his vision, his courage, his resourcefulness, and his energy. Every one has the privilege of building up, but no one has the right to pull down. That is democracy at its best.

In the reconversion and readjustment will come improvements in our standards of life—better houses, better clothes, better food, better safeguards for children, better health protection, and wider educational opportunities. . .

There is no need for postwar depression. Handled with competence, our adjustment, after the war is won, should be an adventure in prosperity. Our soldiers will not be let down. They are our chief concern. No pressure groups of self-seekers will take our thoughts from the duty we owe them.

Finally, while the producers should be restrained from excessive profits during the war, the workers, as long as hostilities are on, should refrain from strikes. No grievance . . . should be permitted to slow our march to victory.

American Industrial Supremacy

Industrial Preparedness—Our Guaranty of Victory and Peace

AT the annual meeting of the officers and directors of the Army Ordnance Association held at the Waldorf-Astoria Hotel, New York City, January 19, 1944, the following statement of Ordnance principles was made by Col. Herbert A. Gidney, president of the Pittsburgh Post of the Association on behalf of the officers and directors of that chapter. By unanimous vote, this statement was then adopted as the policy of the national Association on the subject of industrial preparedness.

¶ On this twenty-fifth anniversary of the founding of the Army Ordnance Association, this society is still dedicated to "Industrial Preparedness in time of peace as our best assurance of peace, and in time of war as our only guaranty of victory," and we celebrate the Association's Silver Anniversary with a reaffirmation of this principle.

¶ In the midst of global conflict, with the greatest productive capacity for war materials the world has ever known, our present problem is to preserve this capacity—through the war years and the peace that will follow—in order to insure the industrial supremacy of America in the production of war material regardless of how long the war lasts and regardless of the type of peace we secure.

¶ This war has proved to the world that industrial production of war materials will, in the last analysis, determine the Nation's power to protect itself. It has also demonstrated that the time required to obtain production of war materials is the choke point in placing an army in the field.

¶ It therefore seems evident that plans for the disposal of war-built plants and equipment should have as their primary consideration the maintenance of an American productive capacity in stand-by condition ready immediately, if the need arises, to outproduce the world in the latest types of war equipment.

¶ Wartime needs should govern decisions as to the disposal of wartime production equipment. We therefore urge upon each branch of our armed services immediate adoption of such plans as may be needed to insure that no military production capacity should be disposed of except in the light of the military requirements of wartime and our country's future defense position in time of peace.

¶ The primary objective in reconversion must be to leave our country so potentially strong that no nation or combination of nations dare attack us.

MEMBERSHIP

in the

ARMY ORDNANCE ASSOCIATION

A MEMBERSHIP SOCIETY OF AMERICAN CITIZENS DEDICATED TO VICTORY THROUGH ARMAMENT RESEARCH, PRODUCTION, AND LOGISTICS

The Association was founded in 1919 to foster an understanding of industry's rôle in our national defense among scientists, engineers, inventors, manufacturers, and other interested Americans, both civilian and military. Its sole purpose is to keep available the highly specialized knowledge necessary for arming the Nation's manhood by stimulating interest in the design, production and maintenance of our weapons of defense. The Association, a membership organization without subsidy of any kind, is carrying on this patriotic work through its national and local conferences; its bimonthly journal, ARMY ORDNANCE; and its monthly news Bulletin of timely industrial-military information.

ELIGIBILITY

The following men are eligible for individual membership: 1. All civilian engineers, scientists, manufacturers and executives of American industry. 2. All members of the military and naval forces of the United States—Regular, Reserve and National Guard. 3. All others interested in our national defense. American citizenship is a requirement of membership. Dues: Four dollars annually. There is no initiation fee and no other obligation.

APPLICATION FOR MEMBERSHIP

THE ARMY ORDNANCE ASSOCIATION,
MILLS BUILDING, PENNSYLVANIA AVE. AT 17TH ST.,
WASHINGTON 6, D. C.

I hereby apply for individual membership in The Army Ordnance Association and enclose annual dues ($4.00) which include ARMY ORDNANCE and all other membership privileges for one year from date of admission. The following statements are true to the best of my knowledge and belief:

Name.....
(Print plainly)

Address.....
(Street and Number)

.....
(City and State)

I am a citizen of.....

Color (race).....

Born at.....Date.....

Educated at.....

Courses.....

Present civil position.....

Previous civil experience.....

.....

Military or naval service (if any).....

.....

If not now in service, was discharge honorable?.....

Present military or naval status.....

.....

References (not necessarily members of the Association).....

.....

.....

Date.....

Signature.....

(Do not write below this line)

Application received.....

Elected to membership.....

Association Affairs

MILWAUKEE POST

THAT America is leading the world in the design and production of heavy artillery was the proud and well-founded boast of Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, before the members of the Milwaukee Post, Army Ordnance Association, at their meeting in Milwaukee on March 8, 1944. General Campbell devoted his address to a description of some of our heavier artillery pieces and cited the high praise that has been received concerning them both from battle commanders of our own forces and from enemy commanders.

COL. W. W. COLEMAN

The meeting, one of the most interesting and widely attended in the history of the Milwaukee Post, was held at the Schroeder Hotel, Milwaukee. Col. William W. Coleman, president of the Post, and first vice-president of the national Association, served as toastmaster. Six hundred and fifty members of the Post and their guests were in attendance. In calling the meeting to order, Colonel Coleman spoke as follows on postwar industrial preparedness:

"Perhaps it is premature to discuss conditions as they may exist after the war, but I cannot refrain on this occasion from expressing one fervent hope; namely, that our people will have become fully convinced that well-organized industrial preparedness will be our surest guaranty of peace in the future. If they are so convinced, the plans and administration of industrial mobilization must receive consideration on a plane equal to if not above that of our military mobilization plan, which would indicate that the industrial phase should be a part of governmental organization and administration. It is in this field of usefulness that the Army Ordnance Association may play an even greater rôle than it has in the past."

General Campbell then spoke in part as follows:

"May I take the liberty, at the start, Mr. Toastmaster, of making a personal reference which I am sure you would not have agreed to had you known about it in advance. It relates to our toastmaster himself. Colonel Coleman symbolizes the very highest type of American industrial executive whose devotion to the national defense of the United States is largely responsible for our present satisfactory Ordnance progress. In the last World War Colonel Coleman served as a special assistant on artillery production to Maj. Gen. C. C. Williams, then Chief of Ordnance of the Army. He helped organize the Army Ordnance Association and in October 1919 was elected its first vice-president, an office he has held without interruption for nearly twenty-five years. During that entire period, his loyalty to Ordnance, his sacrifice of time and personal effort, his leadership in Ordnance thinking, and, above all, his sound judgment helped bring Ordnance to its commanding position in world-wide battle today. Our country can never adequately repay Colonel Coleman and other industrial leaders like him who have given so generously of their time and talents to bring about the armament condition now enjoyed by our American fighting forces.

"One of the most impressive and highly revered pieces of heavy artillery now in the hands of our troops is the gun that is affectionately known as 'Long Tom.' It is the 155-mm. gun on high-speed carriage. It is one of the most remarkable pieces of fighting equipment the world over. In spite of its low over-all weight of about 30,000 pounds, it has a range of more than 25,000 yards. It fires one round a minute, and it has a muzzle velocity of 2,800 foot-seconds. Its carriage is the split-trail type, and it can be towed by a prime mover at the speed of a truck. Its accuracy is so deadly that it is actually accredited with sharpshooting on the Italian front.

"Now let us advance one step higher in the realm of heavy Ordnance in battle and let me tell you about our 8-inch—that is our 200-mm.—gun. It is a honey! It fires a round a minute to a range of 35,000 yards with a muzzle velocity of 2,950 foot-seconds. Its shells are either high-explosive or armor-piercing. Its weight, gun and carriage, is 69,000 pounds. It is one of the most powerful weapons the world over. Bear in mind that your Ordnance Department—advocate of increased firepower—has available for our fighting forces a much more potent weapon which can greatly outrange its adversary.

"And finally there is one more heavy piece well worthy of mention at this time because you people here in Milwaukee are especially responsible for it. Its carriage was actually designed in Colonel Coleman's plant at the Bucyrus-Erie Company, and it is being produced here at this moment. I refer to the 240-mm. howitzer, the largest mobile artillery in our service short of railway artillery. The carriage of this mammoth gun travels in two sections on rubber-tired wagons. It has a range of more than 25,000 yards. It packs a terrific blow! It is one of the most accurate and most destructive mobile weapons of siege warfare ever devised. It is the embodiment of our Ordnance principle of maximum firepower. If a rapier thrust be demanded in battle, Ordnance has the weapons to meet the condition. If a battle-ax be required to hack and hew at the enemy position, again Ordnance has the weapon available. Our 240-mm. piece is a modern battle-ax against which few military targets can stand."

Preceding General Campbell's address, an informal talk was given by Col. L. A. Codd, executive assistant to the Chief of Ordnance, who described the aims and purposes of the Army Ordnance Association.

Frank O. Wyse of the Milwaukee Post, was in charge of general arrangements.

BRIG. GEN. R. H. SOMERS JOINS DARTMOUTH FACULTY

BRIG. GEN. R. H. SOMERS has relinquished his duties as editor of ARMY ORDNANCE and executive secretary of the Army Ordnance Association to become a member of the faculty of Dartmouth College, Hanover, N. H. He is professor of mathematics at Dartmouth where he assumed his new duties March 1, 1944. In relinquishing the secretaryship of the Association which he assumed July 1, 1942, General Somers completed a service to the Ordnance cause second only to his brilliant Army career as an officer of the Ordnance Department. He was retired from active military duty after thirty-five years of service on June 30, 1942.

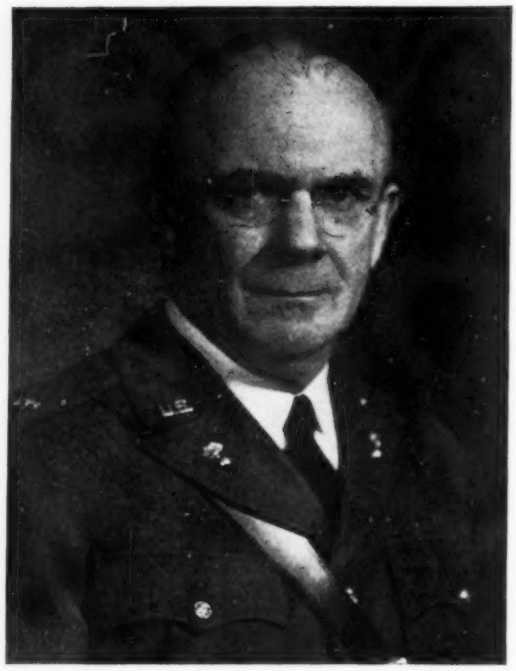
General Somers was graduated from the United States Military Academy, a member of the class of 1907. Subsequently, he was graduated from the Army Industrial College, the Harvard School of Business Administration, and the Ordnance School of Technology. He was one of the founders of the Army Industrial College and influenced in marked degree the early curricula of that renowned institution which played an important part in the mobilization of American industry for the present war.

General Somers' service in the Ordnance Department included posts of highest responsibility at the various manufacturing arsenals and at depots in this country and abroad. At the beginning of this war, he was Commanding General of the Watervliet Arsenal, Watervliet, N. Y., the historic and highly efficient heavy gun factory of the Ordnance Department. He also served as chief of the Ordnance Technical Staff where he was in intimate

contact with the direction of new developments, many of which must await the termination of this war before they can be described in these pages. In addition to his organizational work in the founding of the Army Industrial College, General Somers was in charge of Ordnance R.O.T.C. activities at the Massachusetts Institute of Technology for many years.

To the growth and effectiveness of the Army Ordnance Association he made equally noteworthy contributions. His first service with the Association was in 1922 when he became editor of Army Ordnance and secretary of the organization. He served for three years in these capacities at a time when post-war disinterestedness in Ordnance progress required a degree of leadership which he was well equipped to bring to the Ordnance cause. He returned again to these offices upon his retirement from active military service in 1942. Under his direction, this journal reached new editorial heights, portraying his sound judgment and imparting to its readers some of his breadth of viewpoint. Simultaneously, the Association grew in numbers from 13,720 to 23,078, several new local chapters were formed, and the Ordnance Endowment reached its goal of half a million dollars.

General Somers will be succeeded by Col. L. A. Codd, now on military leave from the offices of secretary and editor which he held from 1923 to 1942. It is expected that Colonel Codd will resume his former duties with the Association at an early date.



Brig. Gen. R. H. Somers

Former editor of Army Ordnance *now on the faculty of Dartmouth College.*

Detroit Post

THE winter meeting of the Detroit Post was held at the Book-Cadillac Hotel, Detroit, on Thursday evening, March 16, 1944. Maj. Gen. R. L. Maxwell, Assistant Chief of Staff, G-4, War Department General Staff, was the principal speaker. Some 650 members and guests of the Post were in attendance. Col. H. W. Alden, president of the Post, presided, and Albert Bradley, executive vice-president of General Motors Corporation, was toastmaster. "War Department Communique No. 5," a motion picture of battle action in Italy and at Tarawa, was shown. General Maxwell spoke on the subject "Is Our Powder Dry?" Excerpts from his address follow:

"We of the Association knew full well that the principles of industrial preparedness for which we stood would one day be the very salvation of our country. That day has come and those principles are supreme. Few, if any, other organizations in this country have contributed more to the welfare of the Nation than we of this great national membership society. We have only one purpose; that is, the industrial supremacy of our country as the strong right arm of our fighting forces in time of war. We have not deviated from that purpose throughout the past quarter century; we shall not flinch in any of our responsibilities in winning the war or in maintaining the peace.

"In the sense that our men on every battle front are adequately supplied, yes, our powder is dry. I can make this statement because recently I had the pleasure of listening to an address by Lieut. Gen. Brehon Somervell, Chief of the Army Service Forces, and to him I am indebted for some of my facts. The American people tonight can rest assured that our fighting men have enough weapons of the right kind, enough ammunition, enough clothing, and enough food. The magnitude of the task of the Army Service Forces in bringing about this condition is well-nigh indescribable. There is no similar effort with which to compare it. In World War I our supply problem involved only one short front on one continent, across one ocean to friendly ports. Our Allies furnished us with much of what we needed. Now we are engaged in a gigantic war wherein our supply lines span all the seven seas to all the six continents. And we have reversed the supply processes with our Allies. In this war they look to us. In the 20 months of World War I we shipped overseas 8,800,000 tons of munitions and equipment. So far in this war we have sent a total of more than 40,000,000 tons of military supplies to points all over the globe.

"In variety of equipment remember always that we must supply a million different items to our men on the front and in the field. To illustrate, I refer to General Somervell's description of supply operations during a very brief period of time on one of his recent inspection trips. First he ordered nine thousand prefabricated houses—at once; next, twelve million feet of lumber—right away; then six thousand 2½-ton trucks—immediately. There followed in quick succession orders for flea powder, guide books, locomotives, tanks, guns and ammunition, shoes and clothing for WACS and nurses, steamboats, blood plasma, spare parts for machine guns, waterproofing, landing barges, freight cars—all right away. As soon as the orders were received the material started moving. Sometimes it was a matter of days, sometimes of hours, sometimes of minutes—but it was on its way.

"The war in Europe will end. We will win, but it will not be easy—Hitler's fortress is strong. An invading army must march through mine fields all the way to Berlin, unless the German people are able, somehow, to throw off the yoke of the Nazis. That is an event for which we all must hope; it would save many lives. But we can't depend on it. No amount of bombing will achieve the final victory, helpful though it is in preparing for it. It takes more than planes, more than bombs, more than production on the home front, more than transportation to win. It takes men—foot soldiers—men with bayonets in their hands and courage in their hearts—that's what it takes. There is no easy way.

"It is encouraging, however, to know that our losses have been small compared with the number of troops involved. This is due to some extent to our better equipment. It is due, also, to the magnificent job our Army doctors and nurses are performing. In World War I, more than sixty out of each thousand wounded men died of their wounds. So far in this war, only twenty-seven out of a thousand die.

"After we have won in Europe, we will still have a long, hard war to fight. Now we are fighting through the outposts of Japan's new empire; the time has not come for our all-out assault, when we will strike Japan from every side with everything we can muster. But the Jap is a brave and fanatical soldier, and so far he will not surrender, as our experience has proved. Unless he changes, we will have to exterminate the Japanese Army. The Japanese have forced us to this decision—we will do a thorough job. We will not pause until we are convinced that Japan has ceased forever to be a menace to the world."

Mr. Bradley, in his opening remarks, emphasized the impor-

tance of the work of the Army Ordnance Association in these words:

"The Army Ordnance Association stands for certain principles of industrial and military preparedness. This Association has for its purpose the improvement in design of war matériel in times of peace in order that our country may be better prepared for war. It is most important that men in industry, as well as in Army Ordnance, continue to keep the fundamental objectives of the Army Ordnance Association active and vital. Certainly, the lessons learned in this war under such trying and difficult circumstances must never be forgotten. We must never allow our Nation to find itself lagging behind any nation in the design of weapons necessary to our defense or in the plans for their manufacture."

Robert L. Biggers was chairman of the committee on arrangements and was ably assisted by Maj. J. W. Paynter, secretary-treasurer of the Post.

Puget Sound Post

A NEW Post recently has been added to the roster of local chapters of the Association. This new unit, with headquarters in Seattle, Wash., is known as the Puget Sound Post. It received its official charter on January 25, 1944.

An informal meeting of the officers and directors of the Post was held on February 3rd at the Washington Athletic Club in Seattle at which Col. James L. Walsh, Association vice-president, was guest of honor. Watt Fallis, president of the Post, presided and outlined the work the Post had accomplished to date. Colonel Walsh then discussed the aims and purposes of the Association and made suggestions for the operation of the new chapter.

Ben Ludlow of the Seattle Chamber of Commerce, a member of the Post, pledged the complete support of the Chamber in the work of the Association. Prof. L. B. Cooper, of the University of Washington, then stated that he would like to coordinate the activities of the various professional societies of the university with those of the Association.

Plans are now under way to increase the membership of the new Post to 2,000 members.

The officers of the chapter are: Mr. Fallis, president; A. F. Parker and E. L. Pease, vice-presidents; C. W. Huffine, secretary-treasurer; and the following directors: Alexander Finlayson, John Nagel, M. B. Mills, and Lieut. Col. C. R. Currier.

Philadelphia Post

FOUR new directors recently have been appointed to the official roster of the Philadelphia Post. They are: H. W. Prentis, Jr., president, Armstrong Cork Company, Lancaster, Pa.; Ralph Kelly, president, Baldwin Locomotive Works, Eddystone, Pa.; R. P. Page, Jr., president, Autocar Company, Ardmore, Pa.; and Chester W. Woolworth, president, Animal Trap Company, Lititz, Pa.

The Post is now in the midst of a very successful membership campaign and has reported an increase from 1,400 members in December to a present total of more than 4,000.

Washington Post

THE Washington Post of the Association is sponsoring a series of lectures on "Ordnance in Battle" in coöperation with the Ordnance Department. These lectures, given by personnel of the Ordnance School, Aberdeen Proving Ground, Aberdeen, Md., have been held on the last Wednesdays of February, March, and April in the Departmental Auditorium in Washington, D. C., and the final lecture of the series will be held the last Wednesday of May. The program consists of a 40-minute lecture followed by a panel discussion with questions from the audience.

The first lecture was given on February 23rd by Capt. J. W. Simpson who spoke on small-arms weapons; the second, on March 29th, by Maj. W. C. Farmer on ordnance in combat; the third lecture, by Maj. R. L. Johnson on antiaircraft artillery and fire control, was scheduled for April 26th. The final lecture of the series will be given on May 31st by Capt. F. P. Hudson who will speak on aircraft armament.

Necrology

LIEUT. COL. FREDERIC W. HINRICHS, JR., dean of upperclassmen and professor of mechanics at the California Institute of Technology, died in Los Angeles February 17, 1944. He was a charter member of the Army Ordnance Association and one of its active and loyal supporters in Southern California.

Born in Brooklyn, N. Y., Colonel Hinrichs was graduated from Rochester University and in 1898 received his appointment to West Point. After being graduated in 1902, he served as an officer in the Ordnance Department of the Army, from which he retired as a captain in 1910. He returned to Rochester University as professor of applied mechanics. Recalled to active duty in 1917, he served in World War I, retiring as a lieutenant colonel in 1920 to become professor of applied mechanics at California Tech.

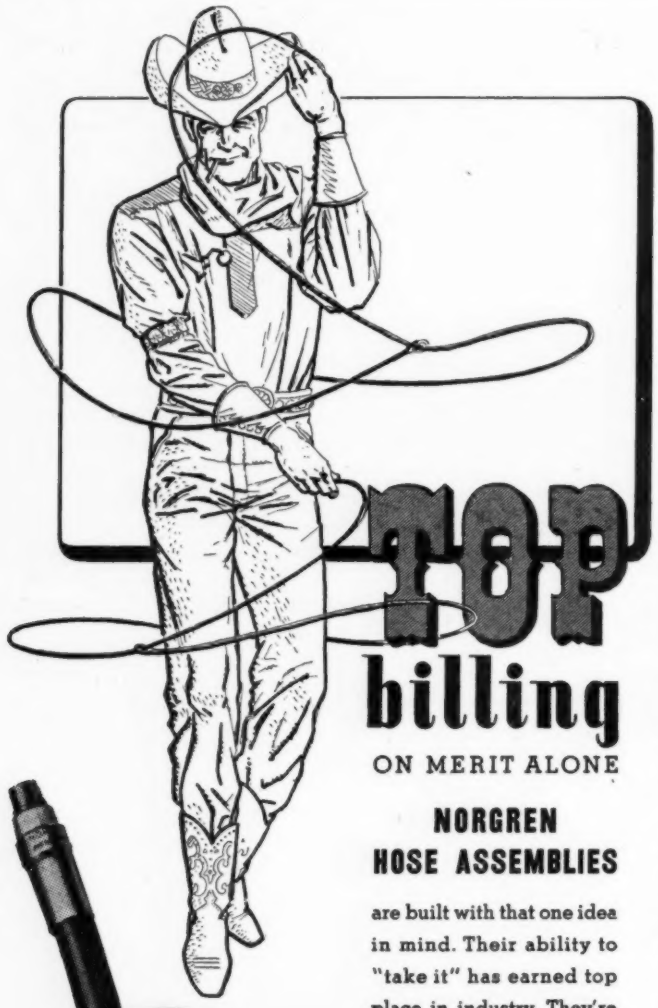
Colonel Hinrichs was the father of Col. John H. Hinrichs, well-known officer of the Ordnance Department and now assistant to Brig. Gen. E. E. MacMorland, chief of the Maintenance Branch, Field Service Division.

ARTHUR H. KUDNER, president of Arthur Kudner, Inc., New York, N. Y., and an active member of the Army Ordnance Association, died in Los Angeles, Calif., February 18, 1944. A recognized leader in financial, economic, and advertising fields, Mr. Kudner was also unsparing of his coöperation in Ordnance affairs. Several years ago when the Association sponsored a mammoth industrial-preparedness conference in New York prior to the beginning of the rearmament program, Mr. Kudner was one of the principal participants and served actively on the committee in charge. He was also active in the American Red Cross and other charitable and patriotic organizations.

HARRY FLETCHER BROWN, a vice-president and director of E. I. du Pont de Nemours & Company, died on February 28th after a long illness at 76 years of age. Born at Natick, Mass., he was educated at Harvard and in 1893 was appointed chief chemist of the Naval Torpedo Station at Newport, R. I., where he collaborated with other naval officers in the development of the present Government smokeless powder. In 1900 he joined the International Smokeless Powder & Chemical Company, and in 1904 was given technical direction of smokeless-powder manufacture at four Du Pont plants. In 1911 he became head of the smokeless-powder department, in 1914 he was elected a director and member of the executive committee, and in 1916 he became a vice-president of the company.

In April 1919, after the emergency of the first World War, Mr. Brown was detached from the smokeless-powder department and became a member of the finance committee of the company. In 1922 he became chairman of the board of the Industrial Salvage Company which was incorporated for the purpose of utilizing or salvaging the war plants of the Du Pont Company which were no longer needed. In 1921 he was reëlected as a member of the executive committee and continued as a member of that committee until his retirement in 1930.

Mr. Brown was also a vice-president of Christiana Securities Company, a trustee of the University of Delaware from which, in June 1930, he received the honorary degree of doctor of science, and was a member and official of numerous charitable and civic organizations.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Ordnance in the Field

Ordnance Maintenance on the Russian Lifeline

Lieut. Col. A. V. Dishman

'Round-the-clock automotive assembly and maintenance on the Trans-Iranian Road—the great Anglo-American supply corridor for the Russian front—constitute one of the most important and most difficult achievements of the Army Ordnance Department in recent years. One of the greatest supply routes in the world is operated by the United States Army in Iran. Formerly old Persia, Iran was so named by the overthrown Shah Reza when he liberated this presently modernized country from many of its former ties to its historic past. Its story is one of the most interesting of all times, for it has been the scene of battles from the dawn of history, and it is unique by reason of its strategic importance as the key to trade between continental Europe and the East.

Persia at one time was the greatest world power and possessed the lands from the middle of India to the Mediterranean, including a major portion of Egypt. However, it was overthrown, rapidly went into a decline, and has never fully recovered. The former Shah Reza modernized his country by building a trans-Iranian railway connecting the Persian Gulf and the free trade of the world with the Caspian Sea. He made the inland city of Teheran, site of the Roosevelt-Stalin-Churchill Conference, one of the most beautiful in the Middle East, established posts and telegraphs, and built modern highways. This modernization has had a remarkable influence on the operation of our present supply route through this great country to Russia.

With little effort, the railway, which the Germans themselves had hoped to use, was quickly converted to the carrying of American Lend-Lease supplies to our Russian ally. Since the railway capacity was not sufficient to move all the supplies desired, a truck fleet was established to augment this capacity. Army Ordnance is playing an important rôle in supplying Russia because it is successfully discharging the gigantic task of maintaining the cargo fleets that haul ordnance and other battle equipment across Iran to the Russian armies which are heroically engaged in a mighty struggle with Germany.

As has already been told, the United States has been supplying Russia with thousands of trucks. These trucks are shipped in crates to Iran where they are assembled in modern plants which are operated by Ordnance personnel and employ thousands of native laborers. One of these plants assembling hundreds of vehicles daily is located near the head of the Persian Gulf, close to the American-made port of Khorramshahr. The other plant is located at Andimeshk, near Shoush of Biblical renown, where Daniel's tomb is located. This second plant is supplied by a 180-mile rail line from Bandar Shapur, the terminus of the Trans-Iranian Railroad which has recently been greatly enlarged by British engineers.

After the vehicle is assembled, it is closely inspected by Ordnance personnel before being turned over to the Russians who again inspect it to insure perfect operation before starting on a several-thousand-mile run to reach the fighting front. After acceptance, the Russians load the vehicles with supplies from the ports and drive them into their own country. In the beautiful city of Teheran a check station is located where the vehicles are checked, lubricated, and put in final working order to insure their fitness for operation in combat or on the great supply lines in Russia itself. This check station is also operated by Ordnance personnel and is an important link in the maintenance of thousands of vehicles.

Numerous Ordnance automotive maintenance companies are established along the supply route and perform necessary maintenance on a 24-hour-a-day basis. Some of these companies are located in the great desert surrounding the Persian Gulf, where the summer sun makes living most difficult. Others are in secluded mountain retreats that must be numbered among the most beautiful spots in the world. The many Ordnance companies maintaining the motor-fleet vehicles are under the Chief of Motor Transport Service. This is one portion of the great undertaking of Maj. Gen. Donald H. Connolly, Commanding

Air Forces

AMERICA DELIVERS THE GOODS TO THE RUSSIANS

General of the Persian Gulf Service Command. These units are responsible for maintaining the vehicles in proper operating condition to insure that an ever-increasing flow of supplies will reach Russia.

In addition, a large Ordnance motor-repair shop and depot is located near Dizful, a city of centuries-old mud huts. Shop buildings were constructed by the British and have walls of mud two feet thick in order to make working conditions possible in the desert sun where the shade temperatures run as high as 140 degrees. The facility was built as a large British base ordnance shop, which would be available to the British Tenth Army in case the Russians were unable to stop the Germans on their march to India. When conditions changed and the Germans were hurled back, this shop area was no longer needed and was delivered complete and unused to the American Ordnance Officer in the theater. It is now one of the busiest spots in Iran, for here vehicles are completely rebuilt with all the new and modern machinery our country has been able to devise and supply for such operations. Here also is located the Ordnance depot which stocks thousands of items of spare parts for fleet operations and, in addition, all the spare parts needed for other Ordnance items in the theater. Not far from this shop is located a large tire depot which stores the hundreds of thousands of spare tires which are necessary for an operation involving the thousands of trucks on this supply line. The tire depot was established by Major Heinton of the Ordnance Department in another British-built depot, which was also handed over to the American Ordnance Officer after the tide of war had changed. This depot was built to store thousands of tons of ammunition but is now converted to tire storage. It is extremely suitable for such storage as the many pits dug into the ground to a great depth are well covered, making them the coolest spots to be found for hundreds of miles and hence perfectly adapted for the storage of tires.

In addition, Ordnance troops have supervised the movement of hundreds of tanks by rail from the Persian Gulf to the Caspian; have supplied ammunition to planes assembled in the area in order that they would be ready for combat when leaving the assembly line; have aided the British in the maintenance of American ordnance; and have aided in many other ways to insure the proper operation of equipment.

RESULTS OF RESEARCH IN WAR CHEMISTRY

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Hydro-Sealed by floating water blanket, new high-performance Carbon Gum Digestive Solvent cleans carbon and paint from aircraft engine parts without harmful effect. Used hot, water seal prevents escape of solvent vapors. (Data Sheet # 236)

High-Potency Concentrate makes Self-Emulsifying Grease Solvent to remove insulating coats of grease and dirt from truck, jeep, tank, and automobile engines by emulsification and utilizing the heat of a warm engine. Cleaned engines operate more economically since original thermal efficiency is restored. (Data Sheet # 237)

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Foreign Weapons

The German Schmeisser Submachine Gun, M.P. 40

1st Lieut. John Gwynne

THE history of the submachine gun dates back to the first World War when, in 1918, the Bergmann M.P. 18I was adopted by the German Army. This gun was the forerunner of practically all the submachine guns being manufactured today. Development of the submachine gun in Germany continued after the war despite the restrictions brought to bear on her by the Treaty of Versailles. Such models as the improved Bergmann, the Styer-Solothurn, and the early Schmeissers appeared from time to time in calibers of less than 9 mm. but with barrels that were very easily replaced with those capable of handling this cartridge.

These guns were well designed, the mechanism being simple, compact, and well made, but they were rather expensive to manufacture. In 1938 the Schmeisser M.P. 38 made its appearance. Many changes had been made in the basic design, resulting in a simple but efficient weapon easily and cheaply manufactured. The frame and magazine guide were machined from castings, and the barrel, bolt, and several small parts were machined products of a high quality. The receiver, folding stock, and magazine were stamped metal. The pistol grips and handguard were made of a plastic—the first time plastics had been used in the manufacture of military weapons.

It was found that in 1940 the Germans had made additional changes in the design of the M.P. 38, and brought out a new model, the M.P. 40. Basically, this is the same weapon. The changes were made to reduce the rate of fire and to expedite further the rapid pace of manufacture already in progress. The receiver was made as a straight piece of tubing instead of being corrugated as in the M.P. 38. Stampings took the place of castings in the frame and magazine well, and the amount of necessary machining was cut to a minimum.

As this is a light, compact weapon, its issuance to and use by

The Schmeisser M.P. 40 with Stock Folded

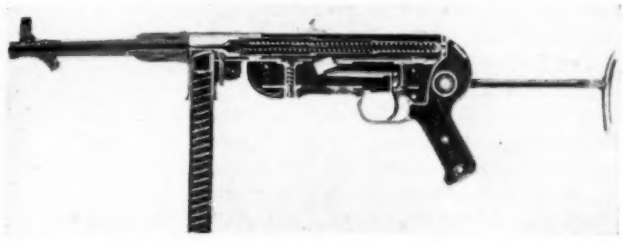
the German parachute troops is obvious. The ammunition problem is simplified because of the ease with which a large amount is carried, and the high firepower which it is possible to attain with a number of these weapons is highly desirable. As time went on, however, and the need for such a weapon grew more apparent (for close work, street fighting, etc.), production was increased and the gun soon found its way into the hands of air-borne troops, *Panzer* divisions, and finally of the infantry until it became the standard submachine gun of the front-line fighting units of the German Army.

The operation of the Schmeisser is based on the blow-back

Lieutenant Gwynne is attached to the Foreign Matériel Branch, Aberdeen Proving Ground, Md. He was assisted in the preparation of this article by Pfc. John E. Holmes of the same branch.

principle. In this type of action the opening of the breech is delayed until the bullet leaves the muzzle and pressure has dropped to a safe degree. The delay is dependent on the inertia of the bolt and the pressure of the recoil spring on the closing stroke. The rearward, or cocking stroke, is accomplished by the use of residual pressure.

Like most weapons of this kind, the Schmeisser fires from an open bolt. When the trigger is depressed, the sear releases the bolt which moves forward under pressure of the compressed recoil spring, stripping a round from the magazine, chambering it and firing. The firing pin protrudes from the face of the bolt at all times, but, by utilizing the spring-type extractor, the cartridge cannot be fired until the bolt is fully closed. The extractor holds the cartridge away from the firing pin until, as the



SECTIONAL VIEW—STOCK EXTENDED AND MAGAZINE INSERTED

bolt closes, the extractor snaps over the rim and into the cannelure of the cartridge allowing the firing pin to contact the primer.

Though there is no provision for semiautomatic fire on this weapon, it is possible to fire one or two shots by quickly squeezing and releasing the trigger, but the gun is not as accurate as it would be if it had this adjustment. However the accuracy is above average since the shoulder stock, in the extended position, is in prolongation with the recoiling parts, thereby reducing muzzle climb.

THE safety arrangement is a practical military type but is not a positive device. To put the gun on safe, the bolt is pulled back until the cocking handle can be turned upward into an L-shaped slot cut into the receiver so that it is held in the rearward position. The cocking handle, if struck by the hand or caught in clothing, could be very easily drawn back and rotated out of this safety slot and the gun put in firing position. A sharp blow on the butt could also result in this condition. It must be noted, however, that this is a military weapon, and a fast and simple arrangement is necessary. A modified cocking handle has been found on recent models of the M.P. 40 incorporating a spring-loaded safety device which locks the bolt in the closed or forward position. When this arrangement is used, however, the chamber of the weapon must be empty.

It is a good practice to lock the bolt in the safe position when loading. The jar necessary to position the magazine is enough to release the bolt, thereby firing the weapon accidently.

The sighting equipment is of the simple open type. The front sight is the usual German inverted "V" mounted on a ramp with a spring-steel cover, and the rear sight is a combination fixed- and folding-leaf type. The fixed leaf is used at 100 meters (109.3 yards), the folding leaf at 200 meters (218.7 yards). The extreme range of this gun is 1,850 yards, but the effective range is only 200 yards.

A folding stock, similar to that on our M3 submachine gun, is used which enables the weapon to be fired from the hand or shoulder. This stock consists of two tubular steel extensions and a pressed metal butt plate. The forward ends of the extensions are fastened to the rear of the frame by a pivot pin which also acts as a lock holding the stock in the folded or extended position. The butt plate is pivot-mounted so that it will lie flat against the handguard when the stock is not extended.

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Foreign Weapons

To use the M.P. 40 as a shoulder weapon the stock lock is depressed, the stock extended and the butt plate snapped into position. In firing, the right hand is on the grip and the left hand grasps the forward portion of the handguard. The use of the magazine as a fore-grip will cause malfunctions, as the magazine is fitted loosely and is easily forced out of alignment. Folding the stock under the gun changes it to a short, easily handled weapon which is held in the same manner as when fired from the shoulder.

The disassembly of the M.P. 40 is very simple and is accomplished without the aid of tools. This is necessary with weapons of this type due to the fact that these guns must be inspected often and that the parts such as the telescoping tubes housing the recoil spring, the firing pin, and the extractor must be readily accessible for cleaning and replacement.

The first step in disassembly is to remove the barrel and receiver from the frame. The receiver lock, located in the forward part of the hand guard, is pulled downward and turned to lock it in a disengaged position. The grip is grasped in the right hand and the trigger depressed. The barrel and receiver can then be turned to the left about one-fourth of a turn and drawn from the frame. The telescoping tubes, recoil spring, and bolt will slide from the rear of the receiver as a unit. The gun is then field stripped and ready for cleaning.

The caliber of the M.P. 40, as that of its predecessor, is 9 mm. (.354). It takes the standard 9-mm. Parabellum cartridge used in such guns as the British Sten, Australian Austen, and the Italian Beretta. The 9-mm. pistol ammunition made for the Luger, Walther P-38, Glisenti pistol, and others will also function in this weapon; however, the use of Schmeisser ammunition in pistols chambered for the 9-mm. cartridge is a dangerous practice as the chamber pressures run higher than those intended for such guns. The bullet is 0.354-inch in diameter and is of the round-nosed, full-jacketed type. The case used is straight and rimless. The length of the complete cartridge is 1.009 inches. The range and penetration of this cartridge are superior to that of the cal. .45 ACP, but its shocking power is not as great.

The magazine is a stamped fabrication and is of the staggered box type. The magazine capacity is thirty-two rounds; however, the weapon will operate much smoother if only twenty-five cartridges are loaded. Loading can be accomplished by hand in the same manner as a pistol magazine, but a special loader is issued with each gun that makes loading much simpler.

The Schmeisser is a reliable weapon and, upon examination, it is found that it is not as susceptible to damage as it first appears. The Russians like this gun and are known to be using it in large numbers. It is also known that many of these weapons are seeing action in the hands of guerrilla forces in many occupied countries.

Editor's Note.—Col. Scott B. Ritchie, in an article entitled "Enemy Weapons" published in the July-August 1943 issue of Army Ordnance (Vol. XXV, No. 139, p. 96), wrote as follows:

"Analyses of enemy weapons have revealed interesting and significant trends in enemy ordnance. German weapons show evidence of typical Teutonic thoroughness and many years of planning for this war. It would be a serious mistake to underrate German ordnance design and manufacture because of a few weaknesses. Every day brings evidence that the Germans are constantly improving the design and manufacture of their weapons. . . Guns of increased firepower are appearing in tanks and on self-propelled mounts. It is *very significant*, however, that none of our investigations or reports from the front have revealed any 'mystery weapon' or any weapon of firepower superior to standard American ordnance. The Germans are using such *ersatz* materials as plastics for gunstocks and steel for cartridge cases. It is quite evident that they have a thorough conservation program."

Professional Digest

AËRIAL INCENDIARIES

THE mounting tempo of our aërial bombing of "Fortress Europe" calls attention to an increasingly powerful air weapon—the incendiary bomb. It is a far cry from 1915, when the Germans first introduced aërial incendiary bombing, to today's wholesale use of these fiery calling cards. The degree to which aviation has progressed has given new and extended application of this type of chemical warfare, and the long-range bomber now carries the battle to military targets far behind the front lines. As the war has progressed, the rain of fire from the skies has increased both in volume and effectiveness. The 1940 German aërial incendiary raids on London pale in comparison with the conflagrations started by our fire bombs in enemy territory.

The Chemical Warfare Service of the Army Service Forces has the heavy responsibility of supplying every category of incendiary to the armed forces. All incendiary items used by the Navy and Marine Corps, as well as by the Army Air Forces and Army Ground Forces, are furnished by the Chemical Warfare Service, which also sends considerable quantities to our allies. In fact, the supply of incendiary matériel now constitutes more than fifty per cent of the work of the Chemical Warfare Service, as measured by dollar volume and it soon will account for sixty-two cents of each CWS dollar spent.

Since, in many situations, the aërial fire bomb now pays greater dividends per pound of weight carried in bomb racks than does the high-explosive bomb, the use of air-borne incendiaries has increased tremendously. At the beginning of the war, incendiary munitions accounted for only about five per cent of our bomb loads; of late, it has averaged sixty per cent and, in some instances, there have been all-incendiary loads. In a recent bombing of Berlin war plants, our airmen unleashed 350,000 fire bombs, which constituted 98 per cent of their entire bomb load.

Chemical Warfare Service production of incendiary bombs goes into hundreds of millions. Seven main types of these bombs already are devastating German and Japanese installations, and other new items are in development which must necessarily remain secret for the time being. In general, the bombs in current use comprise magnesium, thermate, phosphorus, and oil varieties. In size they range from 2-pound "firesticks" to 500-pound "blockburners." All have proved destructive, either alone or in conjunction with high-explosive bombs. The incendiaries are most effective against warehouses, factories, and other combustible buildings but also spread havoc when their blazing chemicals scatter through the rubble caused by the high explosives.

Magnesium bombs weigh two or four pounds apiece and resemble giant metal firecrackers. A bomber can carry as many as 1,500 at a time. Usually released in clusters, they disperse to fall individually, like handfuls of sparks on a carpet. Although only one out of a dozen can be expected to land on something inflammable, their wide coverage can start hundreds of fires almost simultaneously.

The AN-M52 2-pound magnesium bomb consists of an hexagonal, cored magnesium-alloy body containing a thermate igniting composition, an igniting charge, and a hollow sheet-steel tail. It burns for about 8 minutes at a temperature of 2,300 degrees Fahrenheit.

The M50 4-pound magnesium bomb, also hexagonal in shape, has a blunt cast-iron nose and a cored magnesium-alloy body with thermate burning composition, igniting charge, fuze mechanism, and hollow sheet-steel tail. It will burn six to eight minutes at the same temperature as the AN-M52.

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Professional Digest

The AN-M54 4-pound thermate bomb consists of a hollow steel tube with an hexagonal tail. The tubular body holds almost 2 pounds of thermate, which burns for 3 to 4 minutes at 3,400 degrees Fahrenheit, the intense heat melting the steel tube and releasing molten metal to run across the target, setting fires in its path. Because of its intense heat, this bomb is used against targets difficult to ignite. It, too, is dropped in clusters.

The M69 6-pound jellied oil bomb, hexagonal in shape, explodes on impact with spectacular effect. Bursting, it shoots out flaming oil and rubber as far as twenty-five yards in all directions. This bomb is furnished in two types, one containing "gelgas"—a resin-type jelly—and the other a composition which is mixed with gasoline. These bombs also are clustered.

The M47 100-pound jellied oil bomb is a thin-walled shell weighing only 20 pounds when empty and consisting of a rolled-steel cylindrical body 8 inches in diameter and 45 inches long. Formerly it was filled with gasoline mixed with crude latex, caustic soda, and coconut oil. It now contains jellied oil, which scatters on impact in flaming chunks over an area forty yards in diameter. These particles of solidified oil cling to material for several minutes and are difficult to extinguish.

The M76, "goop," or PT bomb, is a 500-pound bomb containing a mixture of jellied oil, finely powdered scrap magnesium, and other ingredients. The ground magnesium shavings, when mixed with other incendiary material, provide a tremendously destructive fire agent. This bomb, which is the most recent type of incendiary to fall on German installations, cannot be extinguished.

The M1 30-pound white-phosphorus bomb, which holds twelve pounds of that agent, resembles a fat cigar with a small propeller and a large steel fin. The phosphorus scatters its sticky, flaming tentacles over an area fifty to one hundred yards in diameter. Besides acting as an incendiary, it is an antipersonnel agent and can also produce dense clouds of white smoke. The M1 is suspended vertically in the bomb bay of an airplane. When released by the bombardier, it falls free, the propeller (or arming vane) spinning for several revolutions and then falling away into space. This frees the bomb fuze for action. The propeller can be set to fall off after about a dozen or more revolutions, depending on how far the bomb is to be dropped before arming itself to explode on impact. This bomb, just short of one yard in length, has tremendous firepower but, because of its relatively light weight, must be released from low altitudes in order to strike with accuracy.

WHEN released from the bomb bay, clusters of incendiaries automatically break open, spreading their packaged fire through space. Each cluster contains up to 128 of the 4-pounders packed together and has a total weight up to 500 pounds. Each cluster includes a certain percentage of bombs loaded with an extra amount of TNT. These special bombs have delayed explosion to discourage efforts to extinguish them.

The M17 aimable cluster is the latest idea in incendiary-bomb packing. This cluster, which has a nose and a tail as though it were one bomb to permit the light M50 bombs to be aimed with precision, drops as a unit from the bombing plane. After reaching the proper altitude, a time fuze imbedded in the cluster explodes a primacord charge and opens up the clustered bombs, which then fall toward the target with greater dispersion.

Since the manufacture of aërial incendiaries is the biggest single procurement job of the Chemical Warfare Service, four CWS arsenals and hundreds of civilian plants under contract to this service are engaged in that work. Primarily, the manufacture of incendiary bombs is a civilian job, the flow of this item being regulated by seven Chemical Warfare Procurement Districts into which the country has been divided for procurement purposes.

Among those plants which have been converted to incendiary-bomb production are former manufacturers of baby shoes, silver-

Professional Digest

ware, vacuum cleaners and washing machines, kitchen utensils, outboard motor boats, fireworks, and many other highly diversified peacetime products. These factories converted with such speed and efficiency that not a single shipment of incendiary bombs to the Air Forces has been held up for lack of production. Four days after Pearl Harbor, the first incendiary bombs were rolling off the assembly line, and the unceasing flow has swelled from month to month ever since. The incendiary-bomb program was given to the Chemical Warfare Service in August 1941; complete plans for bombs and plants were drawn up in about 3½ months, and bombs were being produced in quantity by the end of December 1941.

In order to meet the stepped-up needs of the Army Air Forces, the development of new-type bombs and their quick manufacture has involved great ingenuity in production. For example, in 1942, Pine Bluff Arsenal, Ark., was ordered to have 10,000 heavy bombs of a new type ready by the end of the month; the order was filled in 20 days. More bombs are now coming off the production line there than that arsenal was originally planned to produce with twice the equipment and personnel. The Pine Bluff incendiary oil filling plant is doing 2½ times the work for which it was originally designed. The three other CWS arsenals have similar stories of bomb production achievement.

IN ADDITION to the development and manufacture of new type incendiaries, the Chemical Warfare Service also is responsible for testing these munitions as they come off the production lines. Skip-bomb ranges at Edgewood Arsenal, Md., and Pine Bluff Arsenal make it possible to test sample bombs within a few hours after they are turned out at these installations. Since bombs are not sent overseas until it is determined that they will function properly, this immediate testing guarantees and speeds up supply. Bombs from each lot are dropped from twin-engined bombers flying over these ranges. In skip-bombing tests, the missiles are dropped from low altitudes, strike a concrete mat almost horizontally and ricochet against a thick concrete wall. Observers, equipped with radio for constant communication with the bombing crews, are sheltered in bombproof structures near the target. After each group of bombs is spent, the observers check the results and clear the target for the bomber circling about before it comes in on another run.

At the time that General Doolittle's band of intrepid flyers bombed Tokyo in 1942, America's magnesium supply was low, and the Chemical Warfare Service had to rush manufacture of M54 thermate substitutes for that particular and historic mission. That these bombs accomplished their purpose is attested by reports of the starting of hundreds of separate fires which merged into conflagrations. Since then, both the British and American Air Forces have used incendiary bombs in increasing quantities. In one raid on the shipyards at Kiel, Germany, in the summer of 1943, incendiaries were used exclusively. At that time, formations of B-24 Liberators dropped 202 of the 100-pound clusters containing 4-pound incendiaries and 67 of the 500-pound clusters.

The M47 oil bomb was dropped from Flying Fortresses in the October 1943 attack on the Focke-Wulf assembly plant at Marienburg, East Prussia. Some 1,300 of these 100-pounders were released in that raid, along with several hundred general-purpose bombs. The incendiaries were so effective that General Arnold reported: "This was one of the finest examples of precision bombing to date . . . A study of reconnaissance photographs has convinced the photo interpreters that every factory building and all the hangars had been damaged." More of these oil bombs fell in the Armistice Day and other 1943 raids on the important rail center at Münster, Germany. Others of this type damaged the U-boat building yards at Emden in the blind bombing raid through heavy clouds on September 17, 1943.

Other CWS incendiaries also have demonstrated their power of destruction. The Steaua Roma company tanks were completely

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U. S. SIGNAL CORPS PHOTO

Right, Might—and FIRE POWER!

The pattern of warfare in the Pacific is one of physical toil and hazard, calling for conspicuous gallantry on the part of our armed forces. It is a dirty war, as dirty as the tactics of a cruel and tricky enemy. The incident illustrated above is typical of the stubborn terrain our troops must traverse on the long road to Tokyo. Our fighters are firing one of the most devastating weapons in history's most destructive war, an 81 mm mortar which hurls its mighty charge great distances with deadly accuracy.

This powerful mortar is one of the production miracles of American industry, created by home front worker-fighters including patriotic employees of The F. L. Jacobs Co. who made the fuse to fire this tornado of destruction. It is our proud achievement to manufacture many major ordnance weapons or parts essential to the war effort. This war-working industry has a partnership with fighters wherever they may be, pledging the increasing production of powerful weapons to wage a just war and win a peace secure.

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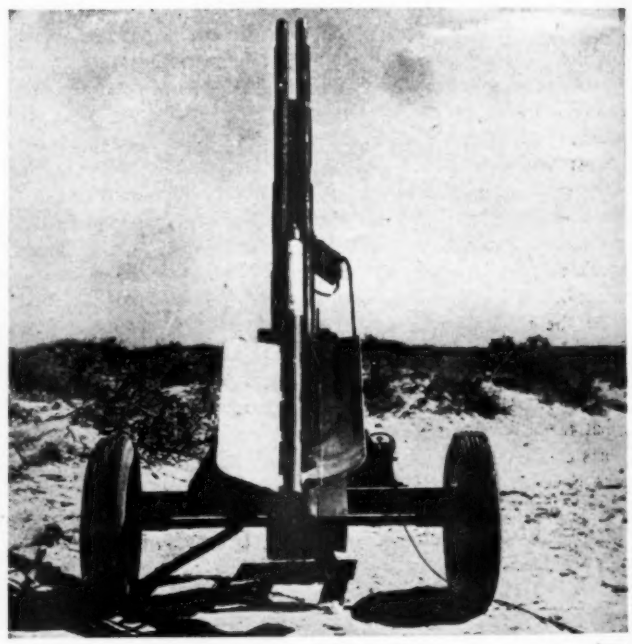
wiped out in the August 1943 raid on the Ploesti oil refineries in Rumania. Every plane on this all-American raid carried some fire bombs. Hamburg was hit with fifty-six tons of fire from the skies on July 26, 1943. Schweinfurt received 88 tons on October 14, 1943, when the incendiary action, together with 485 tons of high explosives, virtually eliminated that German roller-bearing center.

Although it is not generally revealed whether incendiaries were dropped on other specific raids by American and British bombers, the tremendous incendiary production of the Chemical Warfare Service indicates that some fire munition is used on almost every raid. In some raids the proportion of incendiaries is higher than that of high explosives, and in other raids the proportion is lower, depending on the type of target.

Against plants and other combustible material, the incendiaries are tremendously effective. One cluster of bombs can start a dozen serious fires over a wide area. The same weight of high explosives can create much greater destruction over a small area. But fires started by incendiaries can spread for blocks until whole areas are destroyed. With the recent development of "blockburners," such as the 500-pound "goop," the trail of fire from CWS incendiaries can be expected to leap with ever greater momentum through enemy installations.

Antiaircraft Rocket Projector

ANTIAIRCRAFT gunners of the U. S. Army are now improving their accuracy by shooting at fast-moving target rockets fired from the projector shown below. The illustration shows the



Acme

rear of the projector loaded with a rocket ready for firing. The rocket charge is fired electrically through the wire which can be seen connected to the center of the trough.

It was revealed recently that large rocket projectors are in use in London's antiaircraft defenses. These fire high-capacity antiaircraft rockets to great altitudes.

The Ordnance Depots Back the Attack

WHEN the American soldier meets the enemy with the finest weapons any nation has ever supplied her troops, these weapons have already been through one battle and have won. It is a battle through which every weapon produced by Army Ordnance and

Professional Digest

shipped to the soldiers overseas must go before it comes to the final test. Unless it wins this first battle, the weapon is useless for the battle into which the soldier takes it.

The first battle is one with the natural enemy of all overseas shipments—salt water—and since all our troops and those of our allies are fighting beyond the seas, equipment supplied by the Ordnance Department starts out first with a war against salt water. Many Army Ordnance weapons are machined to tolerances as close as one-thousandth of an inch, and salt air is particularly injurious, due to the electrolytic action of the salt on the precision parts. In case the salt air comes in contact with these delicate instruments, corrosive action follows and the weapons will not work if corroded. Special instructions have been issued to all personnel at Ordnance depots having anything to do with the preparation of equipment for shipment to troops overseas to exercise the utmost care in the packaging and preservation processes.

Prewar shipments of costly American machinery never encountered the packaging problems created by these tremendous wartime shipments of supplies and matériel. When shipping space became short, goods remained on docks for long periods and were often shipped as deck loads when ships were available. Adequate storage facilities at overseas points were also limited. All this makes it imperative to devise a foolproof method for fighting corrosion. It was then that Ordnance engineers developed a water-repellent greaseproof paper which has come to be known the world over as "Ordnance wrap." This is used in connection with what is technically called "Ordnance Method No. 2," which consists in placing a moisture-absorbing substance in a container with the instrument before it is wrapped in waterproof greaseproof paper and sealed. Whatever moisture may be within the package is absorbed and the Ordnance wrap prevents the salt-water vapor from getting inside the package.

This method of packaging has made it possible to ship ordnance matériel on the decks of transports and to hold it in open storage in all climates for periods as long as twelve months. As a result, engines, bearings, cylinders, pistons, gears, electrical motors, precision instruments, artillery fire-control instruments, tachometers, voltage regulators, and other delicate articles arrive at the battle front in perfect condition.

The Army Ordnance depots are handling more invasion tonnage than any other facilities of the Army. The Army as a whole handled 41,875,000 tons last year, of which Ordnance depots moved 18,700,000 tons. There are fifty-one Ordnance storage depots strategically located in various parts of the country serving both the European and Far Eastern theaters. During the calendar year 1943, these depots moved 625,000 carloads of battle weapons, automotive vehicles, and spare parts. This would make up a train that would reach from New York to San Francisco and back east past Chicago.

The total land area of all Ordnance Depots is about 292,000 acres, or about half the size of the State of Rhode Island. If all the railroad trackage in Ordnance depots were put end to end, there would be 1,192 miles of track that would reach from New York to beyond St. Louis. Latest statistics indicate that 86,806 people—officers, enlisted men, civilians—are working in Ordnance depots. This is about the size of the population of Harrisburg, Pa. During the month of December 1943, Ordnance depot workers moved twelve per cent more tonnage than a similar number of people in January 1943.

These Ordnance depots have been ordered to get all overseas invasion shipments to the ports of embarkation "sooner than possible." "Don't miss the boat" is the rallying cry for the gigantic supply program that is now going forward at top speed. Commissioned officers are wearing coveralls and are working at night in the warehouses—in addition to their regular duties. Some have been detailed to give all their time to getting the shipments out.

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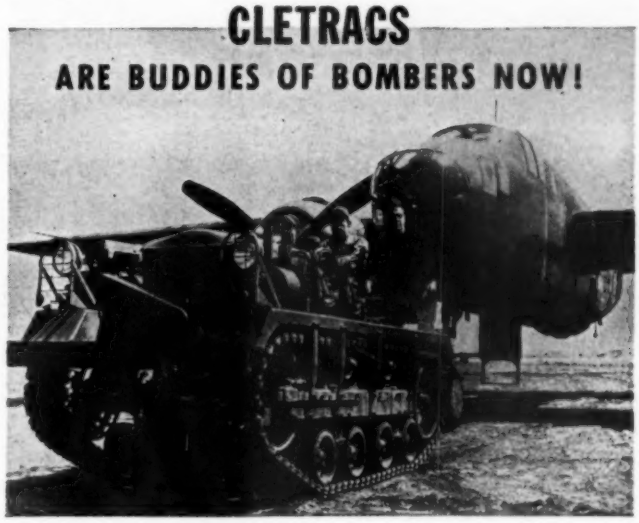

Office of War Information photograph

Squadrons of bombers can take to the air more quickly because of Cletrac's help in moving, arming, fueling, and servicing them for another "Berlin Blockbuster." Every member of ground and flight crews really values the constant help Cletracs give their Buddies, the Bombers.

Servicing planes is only one of many ways in which Cletrac is aiding the armed services with special tractors. Both in this country and abroad Cletracs of all types have transformed forests, swamps, and desert wastes into flying fields and bomber bases. Regardless of climate and soil conditions Cletracs have tackled and licked the tough jobs of building supply and access roads.

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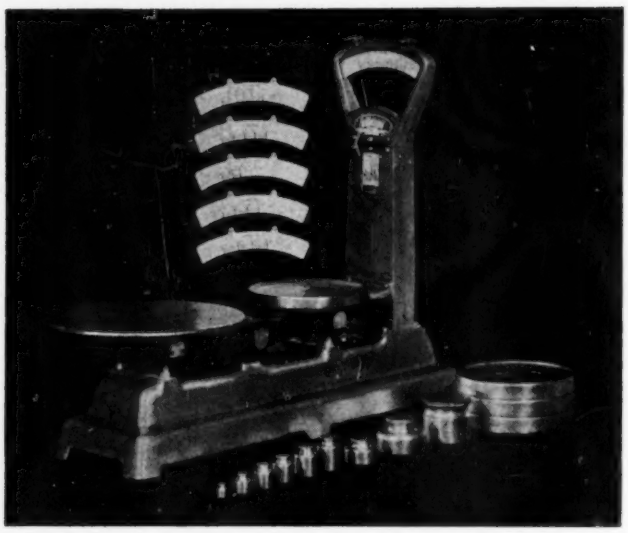

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Many a shell and bullet used in the Marshalls, Gilberts, and at Truk was EXACT WEIGHT zoned. Many a piece of air, sea, and ground combat equipment had EXACT WEIGHT use as well. If you have a predetermined weighing or checking operation in industry calling for a high degree of accuracy under volume production write for the details.

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The magnitude of the spare-parts and general-supply problem confronting the Army Ordnance depots today is shown by the fact that it takes 900 spare parts to keep each General Sherman tank in operation for one year. These spare parts are calculated in sets, one set being the number of parts required to service one hundred tanks in the field for a year. The shipment of a complete set of 90,000 spare parts requires 16 fully loaded freight cars. Nearly 2,000 boxes and crates are required to crate a single set, and more than 4 miles of steel strapping are needed to bind them securely.

The Carbine Grenade Launcher

NOW equipped with the grenade launcher, the lightweight carbine in the hands of a well-trained foot soldier can stop a 30-ton tank. Attachment of the grenade launcher is one of several new improvements which make the carbine more effective than ever.

Use of the grenade launcher gives the caliber .30, 5½-pound, 3-foot-long carbine the same antimechanized firepower as the heavier 1903 and M1 (Garand) rifles which also use it. It can be employed against tanks and men and for pyrotechnic signals. Other improvements to the carbine add to its accuracy of fire and also lessen the effects of recoil and reduce the trigger pull.

Infantry divisions now are equipped with nearly as many carbines as heavier rifles. The carbine's rapid-fire action, light weight, and lesser recoil make it a valuable close-in weapon where there is need for greater power and accuracy than the pistol provides. A soldier can carry approximately twice as many cartridges for the carbine as for the other rifles, since they weigh only about half as much.

P-38 Lightning Now a Long-Range Fighter

A NEW long-range P-38 Lightning, capable of more potent combat performance than any previous Lightnings, is now in action with the Army Air Forces.

Major characteristics of this improved twin-engine, twin-boom Lightning are: Range increase sufficient to make deep penetrations as fighter-escort on bomber missions; thirty per cent increase in horsepower; radical increase in rate of climb at altitudes over 30,000 feet and materially increased rate of climb at all altitudes; straightaway speed increased at high altitudes; service ceiling increased well in excess of 40,000 feet; single-engine speed increased to about 300 miles an hour; combat maneuverability greatly improved by mechanical aids to the pilot; unit power controls and automatic temperature controls to simplify the pilot's operational task.

Installation of an improved turbosupercharger and new intercooler installations, boosting the power of the twin Allison engines to over 1,500 horsepower each, has led to much of the improved performance of the new Lightnings. Externally, the latest model of the P-38 remains practically unchanged in appearance, and structurally it still is the sturdy ship that has seen intensive action on every front. The improved Lightning is a versatile ship, capable of service as fighter-bomber and as escort-fighter. In its rôle as fighter-bomber, the Lightning packs the heaviest bomb load of any AAF ship used in such a capacity. It is a deadly combat weapon in low-altitude bombing and strafing missions. Tankage additions to the P-38 make it a long-range fighter escort and a powerful member of the bomber teams now making deeply penetrating raids on the European continent.

The addition of new aileron boosters, combined with the old combat flap, turns the Lightning into a dogfighter which can outmaneuver many single-engine ships. Armament of the new P-38 remains the same as its predecessors, consisting of one 20-mm. cannon and four caliber .50 machine guns, concentrated in the nose. The P-38 is made by Lockheed Aircraft Corporation.

From the Record

THE ALLIED AVALANCHE IS IN MOTION

FOR the time being, the heaviest concentration of ground and air forces will be in the European theater, though a steady stream of reënforcements flows into the Pacific. The great battles which are impending will decide the course of civilization. The energy and spirit of the assault will determine the duration of the war and therefore the ultimate cost in casualties and war expenditures.

In the European theater, American troops will for the first time face the full power of the German Army. I have no fears whatsoever regarding the ability of the American soldier to meet the situation. Our men are well trained. They are now well disciplined. Many of the soldiers are battle-tested veterans. No Army is better equipped. The troops are an inspiration to their commanders. I do not mean that we will not have troubles and reverses. These are inevitable in large operations, unless the hostile forces are disintegrating. We must expect desperate resistance by the German Army up to the moment the German people throw off the yoke of the Gestapo.

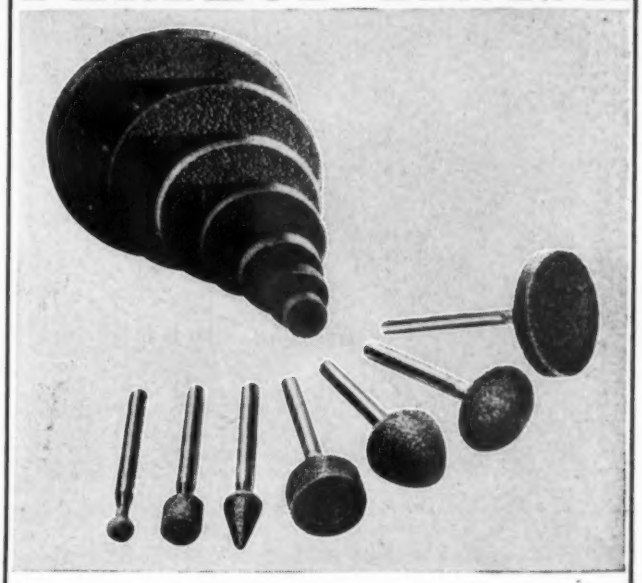
The destruction of German industrial cities is proceeding at a constantly increasing pace. . . Between the RAF night bombardment and the American daylight precision bombing the people of Germany are experiencing the horrors of a war, for which they are responsible, to a degree never before approximated in modern times. Berlin, by far their largest city, is now a shambles. The destruction of other smaller targets will require much less time. More than 2,000 U. S. heavy bombers are now being directed against the heart of Germany, with appropriate diversions into Austria and the Balkans, and the number will steadily increase.

In the Pacific the Japanese have had unusually heavy air and ship losses during the last six months. In the past few days they have suffered an expert demonstration of the overwhelming air and sea power which is rapidly developing in the Pacific and of the perfect teamwork of our landing parties.

The operation in the Marshalls is the first assault on the strongholds which the enemy has been constructing for the past twenty-five years. The fact that the operations have been quickly successful and were carried out without heavy losses is an indication of what is to come as our forces in the South and Southwest Pacific close in with our fleet on the Jap defenses. In brief, the allied avalanche is at last in motion, and it will gather headway with each succeeding month. What is now required is the ardent support of our forces by the people at home. I am not referring merely to the production of equipment or to the purchase of bonds, but rather to the need of a stern resolution on the part of the whole people of the United States to make every sacrifice that will contribute to the victory. The soldiers must feel that the home folk—east, west, on the plains and in the mountains—are completely united in their determination to see this thing through to an overwhelming victory in the shortest possible time.

I speak with an emphasis that I believe is pardonable in one who has a terrible responsibility for the lives of many men, because I feel that here at home we are not yet facing the realities of war—the savage, desperate conditions of the battlefronts. Vehement protests I am receiving against our use of flame fighters do not indicate an understanding of the meaning of our dead on the beaches at Tarawa. Objections to this or that restriction are inconsistent with the devoted sacrifices of our troops. Our soldiers must be keenly conscious that the full strength of the Nation is behind them; they must not go into battle puzzled or embittered over disputes at home. . . —*Gen. George C. Marshall, Chief of Staff, U. S. Army, in an address before the American Legion, Washington, D. C.*

Prelude
TO A
PERFECT FINISH



Just as the prelude to a new world is better tools of war, so the prelude to a perfect finish is better grinding wheels. Today's standards of finishes are far and beyond those of yesterday. To acquire them without sacrifice of production time is a goal which everyone seeks.

Finish must now be measured in micro-inches. That's where the new Chicago FV BOND Wheels excel. They give a precision smoothness so intensified that it passes any surface-analyzer test, in many cases eliminating hand lapping and auxiliary finishing operations.

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Book Reviews

MUZZLE FLASHES. By Ellis Christian Lenz. Huntington: Standard Publications, Inc. 812 pp. $15.

ONE may be forgiven for being a bit staggered at first by the size and cost of this volume. I know of no other American work in the field of small arms which approaches it in either characteristic, if we except the "Catalogue of the Nunnemacher Collection"—an expensive, 2-volume work which has almost nothing in common with the present offering except size and cost. But in these days of stupendous enterprise and comparable outlays, an 800-page gun book selling at fifteen dollars will probably evoke scarcely the flicker of an eyelid among the initiate.

Mr. Lenz's contribution partakes somewhat of the features of Greener's "The Gun and Its Development"—that rock of ages in British arms literature which ran through many editions over almost half a century and which constitutes today, despite certain weaknesses, a veritable arms encyclopædia. But Lenz is less encyclopædic than discursive. He chats amiably with his reader about events in the evolution of small arms and ammunition, giving these always a human touch by bringing into the picture some glamorous or notorious character who can, through fact or artifice, be linked with the item under discussion.

After an introductory (historical) section of 172 pages, Lenz passes to a discussion of American small-arms inventors and makers, devoting the next 132 pages to brief outlines of the stories of Remington, Colt, Winchester, Browning, Garand, and others. Next comes a section of 220-odd pages on the use of weapons and ammunition at the target, from early Colonial days to the 1940 National Matches at Camp Perry.

Section 4 (124 pages) is devoted to the gunsmith and his works, from Joe Manton to Harry Pope *et al,* while Section 5 (140 pages) embraces a discussion of the handloading of small-arms ammunition, followed by a treatise on *Marmota monax* (the humble woodchuck), how to stalk him, and what armament to use for the purpose.

In a foreword to his volume Mr. Lenz says: "'Muzzle Flashes' is the first gun book to be conceived on an illustrative basis and then written." So advised, we are not surprised to discover that the work is replete with illustrations—of the author's making. And more, they are *good* illustrations. The brush drawings of weapons, which are pleasingly numerous, are artistic marvels. They alone are worth the price of admission. It is a pleasure to record Mr. Lenz's entry into the fellowship of American authors who have made substantial contributions to the literature on firearms.

THE ROAD TO TEHERAN. By Foster Rhea Dulles. Princeton: Princeton University Press. 279 pp. $2.50.

OPENING with the observation that Russia and the United States are the only two great nations of the world that have not been at war with each other at some time in their existence, the author continues to outline the relations between the two countries from 1781 to 1943. "The objectives of trade and commerce and the foreign policies of the two nations have generally run along parallel lines." Later, common rivalry with Great Britain and now the direct challenge of Germany and Japan to both countries draws them together.

The difficulties between the nations have not affected the growing friendship that has continued. The several differences which have caused controversy on both sides are explained, not always plausibly, but cogently nevertheless. "The one nation may be following the road marked 'capitalism,' the other the

road marked 'socialism,' but the final destination in each case is a social order in which a decent livelihood, personal dignity, and lasting peace can be assured for the common man." This book is a scholarly treatise on one of the most important subjects affecting this Nation today.

WHY SEAPOWER WILL WIN THE WAR. By Rear Adm. Yates Stirling, Jr. New York: Frederick Fell, Inc. 320 pp. $3.

"UNLIKE the air-minded critics of naval power, I do not belittle the importance of air power in order to add to the importance of naval power." The author concedes the place of air power in the land, sea, and air triumvirate. However, he emphasizes the amphibious landings, the millions of tons of men and materials which are transported by water, and the carrier-based planes that lead the attack. His book is made up mostly of quotations and excerpts from his previous articles published in the daily press.

"ROGER WILCO"—A B C OF RADIO FOR FLYERS. By Lieut. A. P. La Borde. Harrisburg: The Military Service Publishing Company. 128 pp. $2.

WRITTEN in soldier language, interlarded with excellent advice presented in a manner to be remembered easily, this book is just what its title indicates. It is well illustrated and successfully "talks in type," which will make a hit with the average soldier-reader.

GI LAUGHS. Edited by Harold Hersey. New York: Sheridan House. 256 pp. $2.75.

A collection of the editor's choice of verses, stories, and pictures from the legion of Army camp publications. These do not by any means represent the finest in humor, but for good soldier fun, slightly rough and decidedly amateur, this book is an excellect compendium.

A BASIC MANUAL OF MILITARY SMALL ARMS. By W. H. B. Smith. Harrisburg: The Military Service Publishing Company. 213 pp. $2.

MR. SMITH, assisted by an able corps of photographers and illustrators whose contributions add greatly to the interest and value of the work, has produced an encyclopædia of information upon and illustrations of current military small arms which are sure to delight the hearts of "gun bugs" great and small, old and young.

Types of matériel covered include automatic pistols, machine pistols, revolvers, submachine guns, rifles (hand-operated and semiautomatic), carbines, machine guns—light and heavy—and one type of rocket launche (bazooka). Calibers range from 6.5 mm. to .50-inch. In all, some eighty-two different weapons of fourteen nations receive detailed analysis and discussion.

In general, each piece is depicted by one or more cuts accompanied by an extensive summary of its military characteristics and mode of operation. Disassembly and assembly are carefully discussed, the text here being frequently implemented by photographs illustrating the sequence of steps involved. Where indicated, line drawings or pen-and-ink sketches by that youthful genius, George R. Gans, are employed.

Mr. Smith has produced a work which should evoke shouts of praise from every student of current military small arms hopeful of finding, within the covers of a single volume, accurate descriptive data upon most of these.

DER FUEHRER. By Konrad Heiden. Boston: Houghton-Mifflin Company. 788 pp. $3.

KONRAD HEIDEN fought Hitlerism for the past twenty-three years. He followed Hitler "like a Javert tracking down his man" according to Dorothy Thompson. He was forced to

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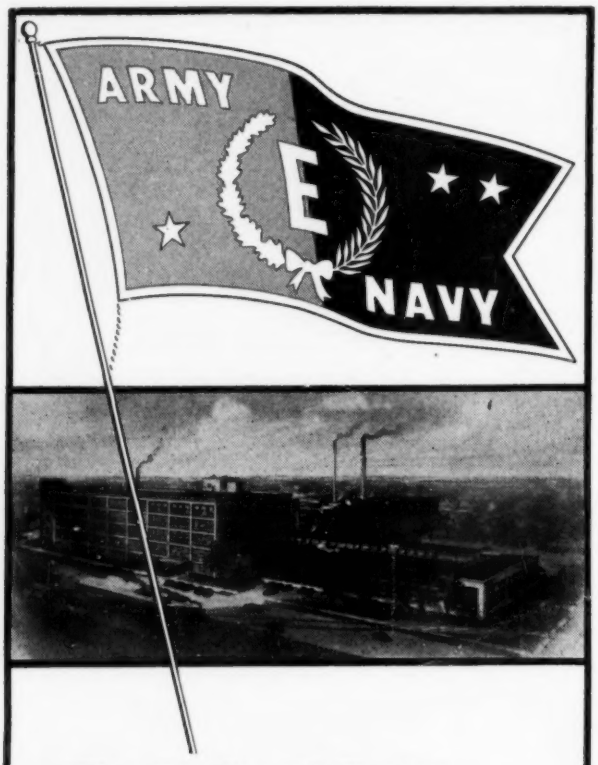

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Book Reviews

escape from Germany, and this book is truly the case book for Hitler, written with understanding and from intimate knowledge of the subject. It will be the source book for future biographers.

The years of Hitler's early life, shrouded in mystery, are here disclosed, showing him as a dreamer—idle, jobless, a vagrant, living in the ghetto. His genealogy with the curious admixture of parents and grandparents gives an insight into the probable reason for some of his later actions. The so-called "Protocols of the Wise Men of Zion," rewritten by a group of unscrupulous Russians from the satirical French "A Dialogue in Hell" are here alleged to contain the warp and weft of the Hitler dogma as we know it today.

The author has written a compact and complete biography not only of Hitler, but of his close associates, Goering, Goebbels, Roehm, and others. It is not a pretty story; it is not flattering—but it rings true.

THE GREAT ANSWER. By Margaret Lee Runbeck. Boston: Houghton-Mifflin Company. 240 pp. $2.

THE stories of fighting men and women—and children—who in time of danger have turned to God are told here in simple language with emphasis on the manifestation of the First Cause, call it what you will—"coincidence," "happenstance," "miracle," or faith. Rickenbacker's experience, the operation in the submarine, and a score of other similar stories that one did not find in the press are included. The classic letter written by Lieutenant Lee to his family from Bataan is republished with the admonition "Do not read this," as if any one could resist this masterpiece of real writing. Scoffers may not be convinced, but these happenings cannot be entirely due to coincidence.

ILLUSTRATED TECHNICAL DICTIONARY. By Maxim Newmark. New York: The Philosophical Library. 352 pp. $5.

THIS is an attempt to contribute to the progress of standardization in the field of technical definitions. This dictionary attempts to supply a wide and representative selection of officially approved standard definitions promulgated by various United States engineering, technical, trade, and industrial organizations, as well as by Government agencies. It contains standard technical definitions of current terms in the applied sciences, graphic and industrial arts, and the mechanical trades. Included also are terms connected with air navigation, meteorology, shipbuilding, synthetics, and plastics. The volume is illustrated and contains technical data and interconversion tables. The author has also published "A Dictionary of Science and Technology in English, French, German, and Spanish."

BOOKS RECEIVED

MOST SECERT . . . MOST IMMEDIATE. By Howard Swiggett. Boston: Houghton-Mifflin Company. 268 pp. $2.

THERE'S NO FRONT LIKE HOME. By Robert M. Yoder. Boston: Houghton-Mifflin Company. 115 pp. $2.

THE MACHIAVELLIANS. By James Burnham. New York: The John Day Company. 270 pp. $2.50.

MAINTENANCE AND SERVICING OF ELECTRICAL INSTRUMENTS. By James Spencer. Pittsburgh: Instruments Publishing Company. 256 pp. $2.

THE AMERICAN WAY. By Dagobert D. Runes. New York: Philosophical Library. 71 pp. $1.50.

THE CHEMISTRY OF SYNTHETIC SUBSTANCES. By Dr. Emil Dreher. New York: Philosophical Library. 103 pp. $3.

INDUSTRIAL COMBUSTION DATA. Hauck Manufacturing Company, Brooklyn, N. Y.

BLUEPRINT READING. By Fred Nicholson and Fred Jones. New York: D. Van Nostrand Company. 141 pp.